REPORT

ON THE

CALCUTTA CYCLONE

OF THE 5TH OCTOBER 1864,

BY

LIEUT. COL. J. E. GASTRELL AND HENRY F. BLANFORD, A. R. S. M.

WITH MAPS AND DIAGRAMS ILLUSTRATING THE ORIGIN AND PROGRESS OF THE STORM AND THE TRACK OF THE STORM WAVE.

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INTRODUCTION.

In the following pages an attempt has been made to give some account of the principal meteorological phenomena that preceded and accompanied the great Calcutta Cyclone of the 5th October 1864. No one can be more fully aware than the authors, how imperfect that account is and how many of the phenomena, on which the fullest information would have been of great value, not only to the scientific meteorologist, but also to the general public, are unavoidably treated in a cursory and incomplete manner. To those who are accustomed to the accurate and minute observations of European Observatories, and who know how much the value of meteorological observations depends on the careful comparison of instruments and elimination of instrumental errors, and on the training and experience of observers, it may seem almost wasted labour to attempt to deduce any results from observations made in many cases by unpractised observers, with uncompared instruments, and from such guesses at the direction and force of wind currents as can be made by persons in their own houses, unconscious of eddies, and judging from a general knowledge of the compass bearings of the place. But these are, for the most part, all that are obtainable in India, and had they been rejected, little would have remained but one or two of the ship observations, those of the Government Observatories at Calcutta and Madras, and those furnished by Mr. R. H. Barnes from Ceylon. The Calcutta observations, moreover, were recorded continuously, or at ten minute intervals, during the earlier part of the storm only, being then intermitted, partly owing to the destruction of the self-registering instruments, partly to the observers having left the observatory building, under apprehension of its destruction by the storm; a catastrophe which at one time appeared imminent.

The authors of the report have therefore endeavoured to utilise all available data within such limits as their local knowledge leads them to believe may be adopted without risk of serious error. Possible thermometric errors of two or three degrees, barometric errors of a few hundredths, and in the case of aneroids and marine barometers, probably tenths of inches, and compass errors of three or four points must in many cases be allowed for, and it would in general be futile to attempt to elicit residual phenomena from such slight anomalies as may be apparent.

While this caution to readers seems a necessary preface to a report prepared, partly at least, for the information of a scientific public, the authors are far from intending thereby to disparage the assistance they have received freely and cordially from all quarters. Whatever record has been kept (to their knowledge) has been frankly and readily communicated to them, and their warmest thanks are due, and are now tendered to all who have thus assisted them. As the names of the different correspondents and observers, to whom the authors are thus indebted, will be mentioned in every case in the body of the report, or in the Appendix, it is unnecessary to enumerate them here; but they cannot omit, in this place, to record their indebtedness to other gentlemen whose names would not appear in the above category.

To the cordial and enlightened encouragement of the Lieutenant-Governor, Mr. Cecil Beadon, at whose desire, the report, which it was originally intended to prepare for the Asiatic Society, is published under the auspices of the Government of Bengal, the authors are primarily indebted. They have thus had the advantage of all such assistance as could be afforded by Government departments and officers at out-stations; assistance which has not only added much to their scientific data, more especially with respect to the height and extent of the storm-wave, but has

enabled them also to complete the record by a more trustworthy account than would otherwise have been possible, of the destruction caused thereby.

To Captain Howe, late Officiating Master Attendant of the Port, Dr. Partridge, Mr. Obbard and Mr. Heeley they owe the collection from ships and private correspondents of much information that they would not otherwise have obtained, and without which the deficiencies of the report would have been much greater than they actually are.

The publication of the report has been delayed much beyond what the authors had wished and anticipated, mainly owing to the demands of other duties on their time; but although this delay will doubtless diminish the interest of the report to the general public, it has been so far an advantage, that it has enabled the authors to avail themselves of greatly increased materials; and the more important deductions in the report have long been available to the authors in their duties in connection with the meteorological system established during the past year.

The subject is treated under the following heads:—

1. Meteorology of the storm area previous to the Cyclone.

2. Formation of the Cyclone and progress to the 4th October.

3. Further progress of the storm over Bengal.

4. Summary of meteorologic phenomena.

5. The Storm-wave.

6. Destruction of life and property.

METEOROLOGY OF THE CYCLONE AREA PREVIOUS TO THE FORMATION OF THE CYCLONE.

The records of the meteorological phenomena which immediately preceded the Cyclone are fewer than could be desired.* But one of the ships' logs, copies of which we have received, reaches to an earlier date than that at which the Cyclone appears to have commenced, and we are thus unable to give any thing like a detailed account of the atmospheric conditions preceding the great cyclonic movement, which appears to have originated on or about the 2nd October to the west of the Northern Andaman. Such an attempt as we shall make to contribute towards this most important part of our subject is based on the records we have received from Ceylon, Madras, and Port Blair, (Andamans,) and those of the Calcutta Observatory, with one or two stations in Bengal—stations far apart, but well fitted for indicating the movements of the atmosphere over a wide area.

The following Table exhibits the direction of the wind, barometric readings and temperature (daily means) so far as we have these data, for the five days preceding the Cyclone :—

Wind Direction.

	27th.	28th.	29th.	30th.	1st.
Kandy, Ceylon	Var. Wy.	WSW.	Var. Wy.	Var. Wy.	WSW.
Madras	ESE.	ESE.	SE by E.	SE.	ESE.
Port Blair	SW.	SSW.	SSE.	SE.	WSW.
Chittagong	Var. Ny.	NW.	Var.	Var.	Var.
Cuttack	S.	S.	S.	S.	S.
Calcutta	SW.	WSW.	Var. Sy.	Var.	Var. S. Ey.
Cachar	Var. Ny.	Var. Ny.	Var.	Var. NWy.	NE.

* We cannot allow this opportunity to pass, without calling the attention of Ship-masters and others, who keep a meteorological record, to the great importance, on such occasions as the present, of furnishing data of at least a week earlier than the commencement of the storm or other phenomenon which it is desired to elucidate. Our object is to ascertain what atmospheric conditions *precede* and *announce* a Cyclone, not less than the phenomena accompanying it. A knowledge of the former is certainly not of less importance than that of the latter, to life and property as well as to Science.

Barometer.

	September.				Octr.	
	27th.	28th.	29th.	30th.	1st.	
Kandy, Ceylon* ...	28·314	28·317	28·358	28·376	28·400	Mean of day reduced.
Madras†	29·897	29·864	29·872	29·880	29·889	„ „
Port Blair‡	29·649	29·696	29·806	29·823	29·703	Noon observation.
Chittagong§ ...	29·84	29·80	29·79	29·81	29·83	Mean of day.
Cuttack‖	29·76	29·73	29·72	29·72	29·70	„ „
Calcutta¶	29·882	29·828	29·817	29·833	29·836	„ „

Thermometer.

	September.				Octr.	
	27th.	28th.	29th.	30th.	1st.	
Kandy, Ceylon	74·5	73·7	72·4	72·8	71·7	Mean of maximum and minimum.
Madras	83·5	83·3	84·9	84·9	84·8	Mean of day.
Port Blair	85	86	86	87	87	Noon observation.
Chittagong	85	85·5	84	84	81	Mean of day.
Cuttack	84·5	87	85	85·5	85	„ „
Calcutta	84·4	85·8	84·8	85·8	84·9	„ „

* Altitude of station 1,560 feet. These means are obtained from the two maxima and one minimum observations by first taking the mean of the two maxima and then the mean of this result and the one minimum. The observations have been reduced to the standard temperature, 32°, by the observer, Mr. Barnes.

† From the Government Astronomer of the Madras Observatory, Mr. Pogson. The observations reduced and means calculated by the observer. Newman's Standard Bar. No. 42.

‡ From Captain E. J. Butler, Commander of *Tubal Cain*, Government Steamer. Reduced by the temperatures given below.

§ From Dr. J. Wise. The mean of four observations; sunrise, 10 A. M., 4 P. M., and sunset: aneroid.

‖ From Dr. J. M. Coates. Also the mean of four observations of an aneroid, *viz.*, sunrise, 10. A. M., 4 P. M., and 10 P. M.

¶ The means calculated in the Surveyor General's Office from hourly observations of a Newman's Standard Barometer.

Of the above instrumental observations, those of Kandy, Madras and Calcutta alone are susceptible of comparison *inter se*. The others are added to show the local changes only.

These three series of barometrical observations if reduced to sea level become —

	September.				October.
	27th.	28th.	29th.	30th.	1st.
Kandy...	29·874	29·879	29·926	29·944	29·973
Madras*	29·917	29·884	29·892	29·900	29·909
Calcutta	29·901	29·847	29·836	29·852	29·855

Hence the atmospheric pressure was increasing steadily at Kandy during the last four days of September and the 1st October, as would be normally the case at this period of the year. At Madras there was a slight fall on the 28th, but a continuous rise afterwards, very small, however, in amount. At Calcutta there was a fall from the 26th to the 29th, and then a very slight rise, but during the whole period the Barometer stood higher than at the corresponding period in any of the previous 10 years, except 1859, as will be seen by comparison of the figures in following Table † :—

	1854.	1855.	1856.	1857.	1858.	1859.	1860.	1861.	1862.	1863.	Mean.
Sep. 27th ...	29·820	[illegible]	[illegible]	29·752*	29·774	29·840	29·714	29·811*	29·615	29·672*	29·756
,, 28th ...	·804	[illegible]	·764*	·749	·794	·819	·719	·753	·609*	·688	·757
,, 29th ...	·746	[illegible]	·703	·731	·829	·838	·709	·718*	·783	·657	·760
,, 30th ...	·723	·774*	·807	·764	·786	·864	·753*	·673	·739	·648	·753
Oct. 1st ...	·737*	·757	·840	·753	·746	·837	·803	·661	·648	·646	·742
Means ...	29·766	·782	·788	·759	·785	·839	·738	·723	·666	·663	·753

* We have no exact information of the elevation of the Madras Observatory, but from a personal knowledge of the site we assume it to be about 20 feet above sea level.

† Until quite recently, no Sunday observations have been taken at the Calcutta Observatory. In order, therefore, to obtain a fair mean result from the 10 years, we have filled in the Sunday observations by taking the mean of the preceding and following days in each case, distinguishing these by a (*). The Barometric waves for the days 28th September to 6th October, for the 11 years, 1854-64, are given in Plate III.

The mean of the five days in 1864 was 29·239 or ·286 higher than the average means of the 10 years.

At the three stations above given the Barometer was high: higher at Kandy and Madras than Calcutta.

At Port Blair it would seem that the Barometer ranged much lower than at any of the above-mentioned stations on the 27th and 28th, but rose 0·047 on the 28th, 0·110 on the 29th, and 0·017 on the 30th. On the 1st October it again fell suddenly 0·12, if the readings of the Barometer of the *Tubal Cain* can be trusted. It may be noticed that these great oscillations (great at least for the latitude) are coincident with the changes of the wind from south-west to south-east, and *vice versâ*, the fall taking place with the veering of the wind to westward. On the 27th and 28th, moreover, with the low Barometer, and south-west and south south-westerly wind, the weather was rainy and squally. With the change to the eastward it became fine and clear, but with the return of the wind to the westward on the 1st, 2nd, and 3rd October there was a return to squally weather and heavy rain.

At Kandy from the 25th to 28th the wind was westerly throughout. "From the 25th to 28th there were fine mornings and forenoons, heavy nimbi and rain, sometimes very heavy, with lightning and thunder in afternoons and evenings, the wind west and west south-west, very light to light. The lower clouds, *cumulo-strati* and *nimbi*, moving variable, coming or gathering up from all quarters, or becalmed. On the 29th the *cumulo-strati* and *nimbi* were again coming up from west and south-west, but there was little rain; the wind at times squally and fresh, west and south-west, and in morning and evening west north-westerly; distant lightning to east north-east. On the 30th cloudy and showery; wind as on previous day; a very fresh to high squall passing over in forenoon, lower clouds moving steadily from west and west south-west. October 1st, raw and very damp; low scud *nimbi* covering the greater part of sky, (dense *cirro-cumuli* beyond,) and moving generally from west south-west, the wind veering from west to south and back. But in the afternoon, for a short time after 2 P. M., the wind went round to the north-east in squalls, the *nimbi* then coming from north and north north-west. Showers, and in afternoon heavy rain, lightning and thunder."*

* Extract from a letter from R. H. Barnes, Esq., of Gangarowa, Kandy. All the Kandy observations are from this gentleman.

At Madras the wind has been steadily from the 17th to the 22nd, blowing with some strength from the 18th to the 20th, and gradually diminishing in force on the following days. On the 23rd and 24th the wind got round to north-west, on the 25th was variable, and on the 26th chopped round to east, becoming gradually more and more southerly, but very light up to the end of the month. The sky was cloudy and overcast, and there were a few showers, while the wind was from the west, but with the change to the east there came fine weather, with light and flying clouds. On the 1st October the wind was light from east south-east, but on the 2nd became northerly, and remained so for the following fortnight, with the exception of a little change (probably due to a local disturbance) on the 5th.

At Cuttack the wind was steadily from the south during the last days of September and the first two days of October. On the 3rd it veered to the north, and blew from that quarter till after the passage of the Cyclone. The Barometer fell slightly from the 27th.

At Calcutta the wind was, as is usual at this season of the year, unsteady, but generally from the south. It had been round to the north once or twice during the month, but without remaining in that quarter more than a few hours. The only noticeable feature in the meteorology of the latter days of the month is the remarkable rise of the Barometer before mentioned. On the 20th the reduced mean reading of the Barometer was 29·605, and from the 20th to the 26th it rose steadily and rapidly, till on the latter date it was 29·917, or more than 0·3 higher than on the former. It fell one-tenth up to the 29th, but rose again 0·019 on the 30th September and 1st October, and remained at an unusually high pressure till the eve of the Cyclone, falling only 0·039 between the 1st and 4th. At Cachar in Sylhet a northerly wind was blowing variably during the latter days of September, and was felt at Chittagong on the 27th and 28th.

Of the hygrometric state of the atmosphere we can judge only from the data afforded us by the Kandy, Madras, and Calcutta observations, which, in the absence of any similar data from Port Blair,

do not throw much light on the primary cause of the Cyclone. For the days 27th September to 2nd October, they are as follow, saturation being 100 :—

	September.				October.	
	27th.	28th.	29th.	30th.	1st.	2nd.
Kandy	88	86	85	86	93	94
Madras	71	70	70	70	74	74
Calcutta	80	78	80	74	78	?

The Kandy observations show the high degree of humidity of the westerly and south-westerly current, which blew from the 29th September till the 3rd October. It was this wind which appears mainly to have fed the Cyclone, as will be seen in our subsequent accounts, and its great humidity offers an explanation of the long continuance and force of the storm. It must, however, be remembered that the current must have been drawn towards the Cyclone region by causes there operating, so that its existence does not offer any solution of the primary cause of the storm.

Such are all the data we have been able to collect respecting the state of the atmosphere antecedently to the Cyclone. Imperfect as they are, we think they are of high interest, not indeed as affording a satisfactory solution of the problem, but as affording indications for guidance in future observations. The primary cause of the movement of air currents towards the middle of the Bay of Bengal, where, as is shown by Mr. Piddington's Memoirs, Cyclones most commonly originate, must be ascertained in future cases by ship observations, and those which it is now proposed to make, under the direction of the Bengal Government Meteorological Committee, at Port Blair and the Alguada Reef. The secondary cause, *viz.*, the inrushing of a nearly saturated current from the south-west, opposed by a weaker north-easterly current, first felt in Eastern Bengal and subsequently over the western part of the Bay, is sufficiently manifest from the foregoing and the data recorded in the following pages.

FORMATION OF THE CYCLONE AND PROGRESS TO THE 4TH OCTOBER.

In the following Table are given the barometric, thermometric, and anemometric observations for October 1st, so far as we have been able to ascertain them. The barometric observations have been reduced for temperature in those cases in which the mercurial Barometer is known to have been employed, but no observations other than those of Kandy, Madras, and Calcutta can be confidently received as admitting of comparison *inter se.**

October 1st.

	Lat. N.	Long. E.	Barometer.	Thermometer.	Wind.	Remarks.
* Kandy [alt. 1560 feet] ...	7°17′	80°37′	28·400 *b*	71·7	WSW.	Mean of day.
Singapore [alt. 50 feet] ...	10°15′	103°51′	30·05 *c*	82	....	Barometer 9 A. M. Therm. mean of max. and min.
Moneka (Ship)	12°	90°34′	29·623 *b*	80	W. to WSW.	Noon observation.
Port Blair	13°20′	93°4′	29·704 *b*	87	WSW.	Ditto.
Tubal Cain, S. S.						
Madras	13° 5′	80°17′	29·889 *b*	84·8	ESE.	Mean of day.
Cuttack [alt. 80 feet] ...	20°29′	85°51′	29·702 *a*	85	S.	Ditto.
Chittagong	22°21′	91°50′	29·830 *a*	81	Var & WSW	Ditto.
Calcutta [alt. 18 feet] ...	22°33′	88°19′	29·836 *b*	85	S. & SE.	Ditto.
Rampore Beauleah ...	24°21′	88°37′	29·81 *c*	86	E & S.	Ditto.
Furreedpore	23°37′	89°54′	....	83	S.	Ditto.
Cachar	24°49′	92°50′	.....	.....	NE.	Ditto.
Comillah	23°28′	91°13′	.....	85	N. & NE.	Ditto.
Darjeeling [alt 7169 feet]..	27° 3′	88°18′	.....	58	SW.	Ditto.
Benares [alt. 318 feet approximately]	25°18′	83° 3′	29·672 *b*	.....	W. & SW.	Ditto.
Agra [alt. 554 feet]	27°9½′	78° 8′	29·314 *b*	83·2	W.	Ditto.

a. Aneroid.
b. Mercurial Barometer reduced to 32°.
c. Character of instrument unknown. Given as reported.

* Our authorities for these observations, and the similar reports for the following days, are as follow:—

Ships.

Moneka, Captain Loftus.
Conflict, Captain A. Kelso.
Clarence, Captain J. Watson.
Sydenham, Captain D. Fox.
Comet, Floating Light, G. L. Barbaro, Esq.
Golden Horn, Captain J. F. Price.
Nile, Captain Owen.
Proserpine, S. S., Captain J. V. Falle.
Chinsurah, P. V., Captain T. Smart.
Foam, P. V., Captain G. B. Smart.

From this table, it appears, that the [illegible] the Bay of Bengal and the country [illegible] to the North, the only exceptions being Cachar in the valley between the Khasia Hills and the mountains of Tipperah, and the station of Comillah, in Tipperah in Eastern Bengal. The only stations at which the wind pressure was recorded are Kandy, Madras, Calcutta, and Agra. These are as follow :—

	Miles in 24 hours.	Mean pressure.
Kandy	69·20	0·045lbs.*
Madras	92·	0·1
Calcutta	.....	2·80†
Agra, 10 A. M.	.....	0·26

and the humidity for the same stations and Benares is as follows :—

Saturation = 100

Kandy	93
Madras	74
Calcutta	78
Agra	65
Benares	31

Land Stations.

Kandy, R. H. Barnes, Esq.
Port Blair .. { Captain E. J. Butler. / Commander, *Tubal Cain.*
Cuttack, Dr. J. M. Coates.
Chittagong, Dr. J. Wise.
Hampore Beauleah, Dr. P. F. Bellew.
Cachar, J. W. Edgar, Esq.
Darjeeling, Dr. B. Simpson.
Agra, Government Gazette.
Singapore, Official Register.
Madras, N. R. Pogson, Esq., Government Astronomer.
False Point, Thomas Geary, Esq.
Calcutta { Baboo Gopinauth Sen, in charge Govt. Observatory.
Furreedpore, Civil Surgeon of Station.
Comillah, Dr. J. Greene.
Benares, Government Gazette.
Balasore, Dr. Jackson.

* Mr. Barnes' Observatory near Kandy is situated at the north-east foot of a high steep ridge, which greatly shields it from the force of a south-west or west wind.

† By Osler's Anemometer.

Meanwhile, in the neighbourhood of the Andamans (*viz.*, to the south-west), a stormy current was setting in from the south-west. This, as we have seen, had been felt at Port Blair to the leeward of the Group, at least as early as the 27th September, from which, or rather the succeeding day, it steadily increased, veering to the south south-east and south-east on the 29th and 30th, and resuming its previous direction on the 1st October, in squalls accompanied by heavy rain.

On the same day (1st October) the *Moneka*, 150 miles to the westward, experienced 'dark, rainy, squally weather, and west to west south-west winds,'—with a low Barometer and with a heavy swell from the south south-west. This lasted till midnight, the ship's course being west north-west, when the wind fell light and baffling from the north-west, but unaccompanied by any rise in the Barometer. On the 2nd the ship's course being the same, the wind continued light and unsteady from the same quarter (between north-west and west), the sky cloudy, but not raining, and the Barometer slowly falling. To the north and north north-east, in the afternoon, the sky "looked very black and lowering," and a high rolling sea came down from that quarter, rising very quickly. By midnight the wind was increasing gradually from the west, the sky to north north-east still gloomy, and the sea still very heavy from the same quarter.

The following is a tabular view of the meteorology of October 2nd.

October 2nd.

Ships.	Latitude North.	Longitude East.	Barometer.	Thermometer.	Wind.	Remarks.
Moneka	12 28½′*d*	89°53′*d*	29·598*b*	82	W by N.	Noon observation.
Conflict	13°27′*e*	90°12′*e*	29·90*c*	...	NNW. to NNE	,, ,,
Golden Horn	14°52′*e*	91° *e*	...	...	NE.	,, ,,
Chinsurah, P. V., at Sand Heads	21° 2′	88°15′	29·783*b*	87	E.	,, ,,

Land Stations.	Barometer.	Thermometer.	Wind.	Remarks.
Kandy (altitude 1,560 feet) ...	25·832*b*	72·4	SW.	Mean of day.
Singapore (altitude 50 feet) ...	29·99 *c*	83	.....	Bar. 9 A. M. Therm. mean of maximum and minimum.
Port Blair (sea level)	29·823*b*	87	SW.	Noon observation.
Madras...	29·847*b*	83·6	N by E.	Mean of day.
Cuttack (altitude 80 feet) ...	29·711*a*	84	S.	„ „
Chittagong	29·81 *a*	83	NW. and NE.	„ „
Calcutta (altitude 18 feet) ...	No observations.		.....	„ „
Rampore Beaulcah	29·822*c*	85	E.	„ „
Furreedpore	...	83	S.	„ „
Cachar	...	...	N. and W.	„ „
Comillah	...	85	N by E.	„ „
Darjeeling (altitude 7,169 feet*)	...	61	SW.	„ „
Benares (altitude 318 feet) ...	29·663*b*	79 2	NW.	„ „
Agra (altitude 554 feet) ...	29·197*b*	85	W.	„ „

The wind force and humidity observations are as follow :—

* *Wind.*

	Miles in 24 hours.	Mean pressure.	Humidity.
Kandy	72·69	0·045 lbs.	93
Madras	179·	0·2 „	74
Agra	...	0·26† lbs.	39
Benares	...	...	32

a. Aneroid.
b. Mercurial Barometer reduced to 32°
c. Character of instrument not specified. Given [illegible]
d. By observation.
e. By account.

* Height of G. P. Station [illegible]
† Pressure at 10 A. M.

From the above it is clear that the Cyclone vortex had formed by noon of the 2nd October, and from the observations of the *Moneka* and Port Blair it seems to have originated on the morning of that day. On the 1st we have seen that the wind, though stormy, showed no indication of a vortical movement, as it blew in the same direction over the *Moneka* and at Port Blair, 150 miles apart, the one to the south-west, the other to the south-east of the site of the subsequent vortex. The swell of the sea, too, on the *Moneka* was from the south south-west until the afternoon of the 2nd, when it came down rapidly from the northward, and the gloomy appearance of the sky in the same direction, which betokened the formation of the Cyclone, was first noticed at the same time. The probable cause of the cyclonic movement will be discussed in another place: meanwhile it will be interesting to notice the phenomena of the incipient Cyclone as recorded in the logs of the *Conflict* and the *Golden Horn*.

At early morning, the *Conflict* experienced "light variable winds from west north-west and north north-west. The stars had a sickly appearance.....and the sun rose blood red." Much faint lightning had been noticed in the night. Up to noon variable smart squalls came from north-west and north, the Barometer still being high. At 2 P. M. the Barometer had fallen 0·04 inches. For the remainder of the day the log is as follows:—"3. P. M. Hard squalls. Sent down royal yards.—4. P. M. Heavy squall from north-west, blowing away jibs, &c. Stowed mainsail, &c.—8. P. M. More moderate. Set mainsail. Barometer 29·80.* Wind west by north. Midnight much rain with lightning; Barometer 29·76."

The log of the *Golden Horn* is as follows:—"Sunday, October 2nd, 1864,—A. M. Winds light from north-west to west, with heavy appearance; vivid lightning and squalls with deluge of rain, each squall getting heavier. Took in main top gallant sail. Forenoon; double reefed the topsails. P. M. Winds north-easterly. Wore ship. Blowing a fresh gale. Spoke the *Wayfarer*, 112 days out, and bound to Calcutta. Latter part of the day and night, strong breeze and deluge of rain."

The decided abatement of the storm, noticed in the log of the first and implied in that of the second of these two ships, is important. At noon, on the 2nd, they were 100 miles apart (see map, Plate I), and both experienced a gale, the wind coming from different directions, owing to their respective positions with respect to the vortex; but their courses being in

* As given in log unreduced. It had fallen 0·06 since 2. P. M., and 0·10 since noon.

opposite directions, by midnight they must have been within 20 or 30 miles of each other, and right in the path of the advancing vortex, supposing that the storm of the 2nd and 3rd were the same cyclonic movement. Indeed on this supposition, the centre of Cyclone must have been passing over or very close to both ships about midnight of the 2nd. Yet there is no indication of such being the case, and hence we can only infer that the Cyclone of the 2nd October broke up while that of the 3rd October was forming to the northward, in much the same way as we find that, at a subsequent date, that of the country south of the Ganges broke up before that which formed on the night of the 5th to the north of the same river. That such was really the case is, we think, borne out by the wind changes as laid down on the map, Plate I.

The log of the *Moneka*, already partly quoted at p. 9, is as follows :—

"From midnight to noon, light and variable winds from north-west to west, with cloudy weather; sea more composed, but south south-west swell as lively as ever. No rain this day. Barometer 29·74 [unreduced]. Thermometer 82°. From noon until midnight, light and unsteady winds from west by north, with cloudy weather; sky looking very black and lowering to the north and north north-east, with a high rolling sea from the same quarter. Sea rose very quickly; observed lightning in the north north-west. Barometer inclined to fall. Midnight, gently increasing wind from west, with gloomy appearances to north north-east. Sea still very heavy from that quarter. Ship pitching, bows under."

Meanwhile, at Port Blair, the Barometer had risen to the same height as on the 30th September, 29·823 inches (reduced), which may be regarded as about the normal atmospheric pressure for the time of year, and is higher than any attained during the ten succeeding days. The wind blew, however, strongly from the south-west, and the weather was squally, with heavy rain.

So far as it is possible to judge of the position of the Cyclone centre of the 3rd October, from the few observations before us, we should infer it to be about North Latitude 13½°, Longitude East 91°, but any estimate of the kind can be only approximative.

For the area beyond the Cyclone tract of the day, as will be seen by the table given above, no important change is observable on the 2nd, except that the northerly current in Eastern Bengal had now reached Chittagong.

Over the Gangetic delta and the Bay, weak variable southerly winds still prevailed. It is much to be regretted that we have been able

to procure no data for any station between Port Blair and Chittagong. There is good reason to believe that the south-westerly current, which we regard as the generator of the Cyclone or successive Cyclones, was steadily forcing its way up the eastern part of the Bay from the 1st to the 5th, but we have no direct information of such being the case, from the comparison of stations of well-ascertained position.

For the Cyclone of the 3rd October our data become more numerous. We tabulate them as before.

October 3rd.

Ships.	Lat. N.	Long. E.	Barometer.	Thermometer.	Wind.	Remarks.
Moneka	13°27′*e*	89°51′*e*	29·469*b*	82	W.	Noon observation.
Golden Horn	14°39′*e*	89°48′*e*	...	...	W.	,, ,,
Conflict	15°10′*e*	91°05′*e*	29·60*c*	...	SSW.	,, ,,
Nile	15°10′*e*	85°51′*e*	29·80*b*	84	NNW.	,, ,,
Clarence	18°17′*d*	88°33′*d*	29·73*b*	85	NE.	,, ,,
Chinsurah, P. V., at Sand Heads	21° 2′	88°15′	29·80*b*	85	NE. & ENE. & E.	Mean of day.
Proserpine, S. S.	20° 9′*d*	90°17′*d*	29·84*b*	80	E.	Noon observation.

Land Stations.	Barometer.	Thermometer.	Wind.	Remarks.
Kandy [altitude 1,560 ft.]	28·287*b*	72·2	Why S.	Mean of day.
Singapore [altitude 50 ft.]	29·98 *c*	81·7	.....	Bar. 9 A. M. Therm. mean of day.
Port Blair [Sea level.]	29 803*b*	87	.....	Noon observation.
Madras	29·813*b*	82·6	NNW.	Mean of day.
False Point	...	...	NE.	Afternoon.
Cuttack [altitude 80 ft.] ...	29·69 *a*	70	N.	Mean of day.
Chittagong	29 782*a*	84	NE. & WSW.	,, ,,
Calcutta [altitude 18 ft.]	29·809*b*	84·4	N. & NW. & E.	,, ,,
Rampore Beauleah	29·74 *c*	83	E.	,, ,,
Furreedpore	...	83	S& calm.	,, ,,
Cachar	...	...	N& W.	,, ,,
Comillah	...	85	NE. & N.	,, ,,
Darjeeling (alt. 7,169 feet)	...	60	E.	,, ,,
Benares [alt. 318 ft. approximately]	29·653*b*	7·97	NW. & NE.	,, ,,
Agra [altitude 554 ft.]	29·274*b*	80·7	.....	,, ,,

a. Aneroid.
b. Mercurial Barometer reduced to 32°.
c. As reported. Instrument not specified.
d. By observation.
e. By account.

The wind force and humidity observations are the following :—

	Wind.		Humidity.
	Miles in 24 hours.	Force in lbs.	
Kandy	93·38	0·1	93
Madras	149·	0·2	80
Calcutta	.....	2·7*	73
Benares	.....	.....	32
Agra	.....	.....	50

On the 3rd October a great change had taken place in the Meteorology of Bengal and the northern part of the Bay. The northerly current, hitherto felt only in Eastern Bengal, now prevailed over nearly the whole of the above area, and extended far down the western part of the Bay. At Calcutta as compared with the observations of the previous week there is a diminution of atmospheric pressure, notwithstanding the northerly wind, but the Barometer is still higher than the average for the time of year. There is no very marked change of temperature in consequence of the prevalence of the northerly current. At Cuttack, the Sand Heads, and Darjeeling there is a fall of 1° from the mean of the previous day, and at Calcutta of 1° since the 1st. At Rampore Beauleah the mean fall since the previous day is 2°, and 3° since the 1st. At Furreedpore and Comillah there is no change, and at Chittagong (where the northerly wind prevailed on the 2nd), the two morning observations of the 3rd show a fall as compared with the mean of those of the previous day, but in the afternoon, the southerly current working up the east of the Bay, reached Chittagong and caused a rise of 3° in temperature, and a fall in the Barometer as compared with the afternoon observations of the 2nd.

In the north-east corner of the Bay the northerly current retreated before its stronger opponent, now forcing its way up the east of the Bay, and the latter, opposed by the Yamadoung Mountains of Arracan on the east and by the north-east current to the north, curved round and blew

* See note page 8.

on the *Proserpine* Steamer in latitude 20° an easterly wind, at first (noon, 3rd October) weakly, but increasing by 8 P. M. to a strong breeze, and accompanied by an increasing swell from the south-east. At 7 P. M. the log records, "dirty appearance to the southward and heavy swell from the eastward. Vessel making very little head way." "Midnight lightning to the eastward, with increasing sea and every indication of bad weather. Barometer falling." The Barometer had fallen 0·10 in. since noon.

At the Sand Heads (log of *Chinsurah*, P. V.) the influence of the recurving current was first felt at 4 P. M., on the 3rd, when the wind changed from north-east to north north-east, and by 8 P. M. to east; the weather, which had been fine all day, then becoming cloudy. By midnight it was blowing fresh from the east, and the weather squally.* The Barometer, however, remained steady, nor did it begin to fall until the forenoon of the 4th.

The *Clarence* bound from Madras to Calcutta, was, at 1 A. M. of the 3rd, in latitude north 16° 35′, longitude north 88° 42′, *i. e.* 260 miles south of the Sand Heads. The wind was then from the north, and there were "squally appearances to eastward. In royals and flying jib, mizen top gallant sail Lc....." At 3 P. M. the wind was east north-east, and at 5 A. M. north-east and north north-east, blowing a strong breeze, and squally. At 7 the weather moderated. "Set driver main and fore top gallant sails.—8. Fresh breeze and fine weather. Noon fresh breeze and squally." Wind north-east, from which quarter it blew till 9 h. 30 m. P. M., when it shifted to the south-east and then to the east south-east, blowing a strong breeze, with squally appearances. At noon the Barometer (reduced observations) stood at 29·73 in; the thermometer at 84°. The ship's course, which is carefully given, hour by hour, in the log, will be seen on reference to the map, Pl. I. The

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* The following is an extract from Captain Smart's private log, for a copy of which we are indebted to him:—

3rd.—"First part, pleasant north-east wind and fine clear weather.—Middle less wind from east; rather cloudy. During the day patches of clouds of a very deep blue, like indigo, overhead and to the eastward. 6 P. M., a very heavy bank of clouds to north-west, of a deep maroon color. First part of night inclined to be squally from east to south-east. Before I went to bed I observed very suspicious sharp and low forked lightning to the south-east. From 10 P. M. to midnight two or three smart squalls from east south-east and south-east.

Clarence was not within the influence of the Cyclone until the morning of the 4th.

On the same day (3rd) at noon, the *Nile*, also bound from Madras to Calcutta, was in latitude north 15° 10′, latitude east 81° 51′. In the early morning she had experienced "light north-easterly airs, and fine daylight; wind north and freshing. Forenoon, north north-west breeze and fine. Noon, moderate north north-west breeze. Afternoon, hard squalls with heavy rain from north and west. Sunset, wind unsettled; 7 P. M., squalls with rain; wind unsteady from north north-west to north north-east; midnight, moderate breeze and cloudy."

The Barometer at noon stood at 29·80 (reduced observation), the Thermometer at 84°. On the afternoon of the 3rd the *Nile* was within the influence of the northerly wind of the western part of the Bay, now curving in to feed the Cyclone. "P. M.—Hard squalls with heavy rain from north and north-west. Sunset; wind unsettled; split fore-royal. 7 P. M.—Squalls with rain, wind unsteady from north north-west to north north-east. Midnight, moderate breeze and cloudy."

Meanwhile the *Conflict* and *Golden Horn*, after crossing between the sites of the Cyclones of the 2nd and 3rd, were within the influence of the latter on its opposite limbs, at noon of the 3rd. The log of the *Golden Horn* is as follows:—"3rd, A. M. Strong breeze and squally, with dark weather; wind north-westerly; ship heading south-west by west. —8. Wore ship; wind moderated; out all reefs; set top-gallant-sails and stay sails. During the forenoon strong breeze and heavy head-swell; noon, wind westerly." Thus between noon of the 2nd and noon of the 3rd the wind had backed from north-east to west, a change so far equally compatible with the passage of a Cyclone to the eastward of the ship, and with the formation of a second Cyclone to the northward.

At noon the course of the *Golden Horn* was northward, and therefore nearly parallel to that of the Cyclone of the 3rd, but gradually nearing it, and we accordingly find the weather getting worse, and distinct indications of the position of the Cyclone in the direction of the wind and in the swell which now bore down on the ship. "P. M. Weather thick, with fresh wind and squally. Heavy swell from east north-east, wind backing to the south-west, with hard squalls and heavy rain. Latter part, hard squalls, and wind hauling aft; in small sails. Midnight, blowing heavy, with a deluge of rain; wind south: course north by west."

Like the *Golden Horn* the *Conflict* experienced a moderation of weather on the night of the 2nd, but on the 3rd her northward course brought her within the influence of the second Cyclone, as is shewn by her log as follows:—

"October 3rd, A. M. Much rain. 3 A. M. Much lightning to the north-west, with a frightful squall lasting about 1½ hours; stowed mainsail and upper topsails; close-reefed mizen topsail. Barometer (unreduced) 29·70. From 4 to 8 hard gale with frightful squalls, with thick dense clouds in the north-west. Barometer (unreduced) 29·68. Stowed the foresail. Forenoon; heavy rains; wind veering to west south-west, with heavy squalls. Ship hove to on port tack. Noon. Barometer (unreduced) 29·60.

"P. M.—Wind from south south-west, with very heavy rains and squalls up to 2 P. M. Ditto weather: set foresail and ran to north by west* at the rate of 12 knots per hour. Barometer (unreduced) 29·60.—4 P. M. Wind south, hard gale and confused sea, with heavy rain.—8 P. M. Barometer (unreduced) 29·62. Up to 10 P. M. fine stars out for a short time as if showing through a thin fog.—11 P. M. Wind south south-east; very heavy squalls; ship running to the north at 11 knots per hour; sea much confused. Midnight. Barometer (unreduced) 29·64."

At first sight it might seem from the above log that the *Conflict* ran into the centre of the Cyclone on the evening of the 3rd, the confused sea and fine weather that lasted for two hours, preceded and followed by heavy squalls, tally so well with the recorded descriptions of storm centres. But this explanation, though possible, is hardly probable, the Barometer being no lower than 29·62, (which, if a mercurial and reduced, would probably be about 29·57), and having risen slightly during the preceding six hours. Moreover, unless the ship's position was really considerably to the westward of her corrected course (as laid down on our map) the position of the centre from 8 to 10 P. M. would not tally with that indicated by the direction of the wind on the

* We have inserted the presumed course of this ship, as inferred from her log, as a dotted line. This tallies much better with the Barometric readings (as indicating her proximity to the Cyclone, than that deduced from her noon position on the 3rd, which is by account, and may further be open to some error in copying. If the former be accepted, the wind arrows and Barometer readings should be transferred.

Golden Hyæ.* It seems, on the whole, more probable that the fine weather was due to the interference of two eddies, such as is described by Admiral Fitzroy,† than that the ship was in the centre of the Cyclone.

Finally, we give the log of the *Moneka*, on this day sailing up slowly in the rear of the Cyclone.

"October 3rd.—From midnight till 10 A. M. a fresh and unsteady breeze from west, with cloudy weather, but looking very black to the northward. Sea also very heavy from the same quarter; so heavy that bowsprit dipped at times. At 10-30 A. M. wind shifted suddenly to north-west and north north-west. Rain falling in a solid mass, and accompanied by heavy gusts, and calms during short intervals. Ship made snug; Barometer 29·61 (unreduced). Thermometer 82°.

"From noon till 6·30 P. M. wind flew out from west; more settled appearances. Sea still very high and confused. Midnight wind fresh from west south-west. Finer weather; Barometer (unreduced) 29·61 Thermometer 81°."

It may be observed, on comparison of the wind observations of noon of the 3rd with those of the 4th and 5th October, that they conform more nearly than on any subsequent day to the directions required by the theory of Cyclone constitution adopted by Colonel Reid and Mr. Piddington. If a large horn card, such as that devised by the latter gentleman, be placed on our chart, with the centre coinciding with our inferential position in latitude 16° 30′, longitude 90·30, the wind arrows (colored blue) will nearly form so many tangents to the circles on the card. It would, however, be incorrect, we think, to regard the Cyclone, (meaning, by this term, the gyrating currents due to the ascending current over the vortex) as extending over the greater part of the Bay. The disposition of the wind currents on the 3rd is evidently that of a great eddy, formed, in the first instance, by the recurvature of the south-westerly current, the rectilinear progress of which has been opposed by a comparatively still mass of air. It is apparently the first step to the formation of a Cyclone. When the vortex was fairly formed and advancing, the wind current began to converge towards it, the strongest being from the eastward

* We assume the directions of the wind in the Cyclonic *vortex* to have been throughout similar to those which demonstrably prevailed during the passage of the storm over Bengal, *viz.*, converging and spiral in the immediate neighbourhood of the centre, not truly circular as supposed by Colonel Reid and Mr. Piddington.

† Weather Book, p. 239.

From the 3rd October we can trace the progress of the storm with some confidence, in its advance, at the average rate of 10 miles an hour towards the mouth of the Hooghly. The observations of the 4th October are as follows:—

October 4th.

Ships.	Lat. N.	Long. E.	Barometer.	Thermometer.	Wind.	Remarks.
Moneka	15°21′ *f*	89°45′ *f*	29·459*b*	82	SSW. to W.	Noon observation.
Golden Horn ...	18°48′ *e*	88°54′ *e*	....	....	S. to SSE.	"
Conflict	18°11′ *e*	92°45′ *e*	29·60 *c*	....	SE.	"
Nile	16°41′ *e*	87°11′ *e*	29·67 *b*	85	WNW.	"
Clarence... ...	18°56′ *e*	88°12′ *e*	29·449*b*	82	N.	"
Proserpine, S. S.	20°30′ *e*	90°40′ *e*	29·596*b*	83	E.	"
Chinsurah, P. V..	20 miles S. of E. C. Light.		29·658*b*	82·5	E.	"
Comet, F. L. V....	On E C. Station Sandheads.		29·706*b*	.....	ENE.	"

Land Stations.	Barometer.	Thermometer.	Wind.	Remarks.
Kandy [altitude 1,560 feet].. ...	28·283*b*	71·6	S. & SW. & calm.	Mean of day.
Singapore [altitude 50 feet]	29·96 *c*	80·7	.....	Barometer 9 A. M. Therm. mean of max. and min.
Port Blair [sea level]	29·803*b*	87	Variable.	Noon observation.
Madras	29·812*b*	82·8	NE. by E.	Mean of day.
False Point	29·548*b*	80.	NE.	
Cuttack [altitude 80 feet]	29·627*a*	79·7	N.	Mean of day.
Chittagong	29·802*a*	78	SSW. & NE. & SE.	"
Balasore	29·79 *c*	81	NW. & N. & NE.	"
Calcutta [altitude 18 feet]	29·797*b*	79·5	E. & S.	"
Rampore Beauleah	29·767*a*	83	E.	"
Furreedpore	....	81	S. & calm.	"
Cachar...	....	....	E & N. & SW. & W.	"
Comillah	....	83	NE. & S.	"
Darjeeling (altitude 7,169 feet) ...	....	59	E.	"
Benares [alt. 318 feet approximately]	29·650*b*	79·5	SW. & NE.	"
Agra [altitude 554 feet]	29·236*b*	80·5	W.	"

a. Aneroid.
b. Mercurial Barometer reduced.
c. As reported. Instrument not specified.
d. By observation.
e. By account.
f. By account from observation of Fomelhaut at 10 P. M., 3rd October.

	Wind.		Humidity.
	Miles in 24 hours.	Pressure in lbs.	
Kandy	111·28	0·1	89
Madras	89	0·045	76
Calcutta	.....	.....	83
Benares	.....	.....	40
Agra	.....	0·26	32

At noon on the 4th the centre of the Cyclone was passing betwee the positions of the *Clarence* and *Golden Horn*, the wind blowing fro opposite quarters on these two ships. If these positions are correctl given in their logs,* both ships must at this time have been very nea the centre, as they were but 32 miles distant from each other. Yet th Barometer of the *Clarence* does not indicate a lower pressure than 29·449, and two hours later, when at its minimum, the reduced reading is onl 29·21. The course of the *Clarence* round the centre of the Cyclone, b which the ship escaped injury, and, taking advantage of the tail wind was enabled to make a rapid run up the Bay, is indicated on the ma Plate I. The *Golden Horn*, on the other hand, appears to have run up int the Cyclone, the centre of which, passing to the north-west, crossed h track ahead of the ship, on the night of the 3rd and 4th. By noon of t 4th she had overtaken the centre, her position being a few miles to t east of it, but having altered her course to the north north-east, whi that of the Cyclone was to the west of north, she gradually extricat herself from the storm, retaining the advantage of the wind, and equall with the *Clarence*, making a rapid run up the head of the Bay.

The following are Extracts from the logs of these two ships. Th log of the *Clarence* is given in *extenso* in the Appendix:—

Clarence.—1 A. M. Wind north-east, strong breeze and squally, wi rain.—3 A. M. Wind east north-east. Heavy squall from eastwar

* The care and detail with which the course of the *Clarence* is recorded do not ad of doubt on this point, and we have no reason to question that of the *Golden Horn*.

† Reduced to 32°.

Lowered the topsails. Barometer 29·75* (unreduced).—5 A. M. Wind north-east, increasing to a gale, with every appearance of bad weather. Shortened sail to close reefed topsails.—7 A. M. Wind north-east by east. Barometer 29·70. Sent down the royal yards, &c.—9 A. M. Barometer 29·72.—10 A. M. Barometer 29·60. Every appearance of being near a Cyclone. Bore up to south south-west, and furled mizen topsail.—11 A. M. Wind veered to north north-east. Blowing hard with torrents of rain, and a confused sea on. Barometer 29·63.—Noon. Barometer 29·59. Wind veered to north. Hard squalls, very heavy rain, and a confused sea on.

1 P. M. Wind north north-west. Barometer 29·50. Blowing a hard gale with furious squalls and torrents of rain. Kept the ship before the wind, altering her course as the wind veered.—4 P. M. Barometer 29·35. Wind west south-west. High cross sea on.—5 P. M. Wind south-west by west. Barometer 29·38. Blowing most furiously, with a deluge of rain. Secured sails, boats, &c.—5h. 30m. Barometer 29·36. Having sailed round the Cyclone till the centre bears north-west, furled the fore-topsail and hove to, under close reefed main topsail. Wind south-west.—8 P. M. Barometer 29·54. Wind south-west. Hard gale, with constant rain.—10 P. M. Strong gale, with hard squalls and heavy rain.—Midnight. Barometer 29·66. Wind and weather the same. Heavy sea on.

Golden Horn.— A. M. Wind south south-west to south; blowing a heavy gale, with deluge of rain. Heavy sea from east south-east, ship rolling heavily at intervals. During the forenoon hauled up to north north-east, to keep her steady. Set main topsail.—Noon. Wind south to south south-east.—P. M. Blowing a heavy gale. Took in the main topsail, ship going much easier. Split the fore-topsail. Took it in and hauled sharp up to north-east by east, and let her go under spanker topsail and fore-top-staysail. Latter part; wind hauling to the south-east. Towards midnight less wind.

While over the eastern part of the Bay, the southerly wind current continued to blow strongly, and over its western half the northerly current prevailed, the incurvature of both towards the vortex of the Cyclone was very distinct, as is shewn by the purple wind arrows on the map, which are those for noon of the 4th. In Bengal the wind was either easterly, (Calcutta, Berhampore, Rampore Beauleah, Bograh) north-east, or variable (Furreedpore, Cachar, Comillah) or calm, (Dacca.)

* The barometric readings quoted in this Extract are all unreduced.

At Chittagong it blew from the north-east during the earlier part of the day; and in the afternoon a violent squall from the south-east ushered in a south easterly wind, which blew for the remainder of the evening and all the next day. The Barometer (aneroid daily mean) had fallen 0·05 from the 1st to the 3rd, but rose 0·02 on the 4th, falling again on the 5th to the same degree.

At Calcutta, the Barometer (daily mean) had fallen 0·04 inches since the 1st of the month, but was not below the average reading of the time of year. The weather was cloudy with a little rain, (0·20) in the afternoon and evening. About dusk, the wind, which had been south-east during the afternoon, began to draw round to the east and to blow in gusts, gradually increasing in strength, but not materially so until after midnight, (see Plate V). The Barometer indicated the usual daily tides, and continued rising up to 8 P. M., from which time it began to fall,* so that by midnight it had descended 0·064 inches, and was considerably lower than at the hour of the afternoon minimum.

At Balasore, the wind was from the north-west on the morning of the 4th, and veered round by north, (10 A. M.) to north-east (4 P. M.), from which quarter it began to blow hard about 8 P. M. In the night it backed to north north-west, "from which point it seems to have blown with the greatest violence, as all the trees that were uprooted in the station fell to the south south-east."† The Barometer, (whether a mercurial or aneroid we are not informed,) fell 0·025 between sun-rise and 10 A. M., (the usual hour of maximum,) and 0·015 between that hour and 4 P. M. Its minimum depression was not recorded, but at sunrise next morning it stood at 29·450, or 0·325 lower than the 4 P. M. observation of the previous day.

At Cuttack, the Barometer (aneroid daily mean) rose 0·02 on the 2nd, fell to same extent on the 3rd, and further 0·07 on the 4th. The lowest reading recorded is that of sunrise on the 5th, 29·50,‡ but it had probably been lower in the night, as the Cyclone had passed considerably to the north of Cuttack by daybreak on the 5th. The wind was steadily from the north, from the morning of the 3rd to the afternoon of the 6th, but no storm was felt and no rain fell.

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* As may be seen on reference to Plate III the Barometer usually is either steady or rises slightly between 8 and 10 P. M.

† Extract from a letter from Dr. Wise, to whom we are indebted for the greater part of the information we have received from Balasore.

‡ The instrument appears to read low, as much probably as 0·10, if not more, after allowing for its elevation (80 feet) above the sea level.

At False Point* (60 miles due east from Cuttack) it blew a moderate breeze from the north-east on the afternoon of the 3rd. During the night the wind freshened, and on the morning of the 4th became "nearly a gale," blowing in squalls with passing heavy showers. The Barometer (reduced) stood at 29·543. At 4 P. M. the wind veered round to the north-north-east, and increased to a gale, blowing in fierce squalls with very heavy rain, the Barometer slowly falling. At 8 P. M. it blew in the same way, the Barometer being 29·454. At 11 P. M. the wind veered to north-west, still blowing in squalls accompanied by heavy rain.†. Between 1 and 2 A. M. (5th October) the wind veered to west, and at 3 A. M. began to moderate. At daylight it blew a moderate breeze, diminishing as the sun rose.

The Cyclone centre therefore passed to the east of False Point between 8 and 11 P. M. on the night of the 4th, or probably about the later hour, and, as appears from the track, at a distance of about 80 miles.

At the Sandheads, and generally throughout the north of the Bay, the fury of the storm was chiefly felt on the night of the 4th. The logs of the Light Ship and Pilot Brigs stationed at the E. Channel Buoy, more especially that of the *Chinsurah*‡ (Captain T. Smart, Commander,) give a good account of its approach. From these we summarise the following. The logs will be found in *extenso* in the Appendix:—

At the Sandheads, the easterly wind, which presaged the Cyclone, sprang up on the afternoon of the 3rd. During the night it increased to a fresh breeze, with squally weather and heavy rain, but unaccompanied by any decided fall in the Barometer up to noon of the 4th. Early in the morning of the 4th, and while the wind was still light, a very heavy short sea rolled up from the south-east, and the weather all round had a very threatening appearance. The *Chinsurah* weighed and stood down to southward, drifting with the tide, as the wind was too light to enable the ship to steer in the heavy sea. As the morning advanced, the wind freshened, still from east north-east; weather squally, and a

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* These details are taken from an official letter from Mr. Thomas Geary, Superintendent of the Light-house, to Captain Howe.

† A later letter from Mr. Geary states that the lowest reading of the Barometer was 29·49 (= 29·354 reduced), but the hour is not stated.

‡ We are indebted to Captain Smart for a copy of his private log, in addition to that of the official log received from Captain Howe.

heavy sea rolling up from the same quarter as before. Shortly after noon the Barometer began to fall, and the weather getting rapidly worse, at 4 P. M. the cable of the *Foam* parted, and the ship stood out to sea, heading to south south-east. It was then blowing a hard gale from east by north, with strong squalls and thick rain; the Barometer had fallen 0·13 since noon. At this time the centre of the Cyclone bore south by east about 130 miles, and was advancing at the rate of about 10 or 11 miles an hour.

The Lightship *Comet* still rode at anchor on her station, hatches battened down, and shipping heavy seas, up to 11-30 P. M., when her cables parted and she began to drift to west north-west. The storm had been getting worse hourly, and the Barometer fell 0·35 from noon to midnight, when the wind was still blowing in heavy gales from east north-east.

Meanwhile the *Chinsurah* was making her way southward under double-reefed topsails, the wind blowing in squalls from east and east north-east, accompanied by heavy rain. The Barometer stood at 29·809* at 8 A. M., having risen 0·02 in the previous four hours. By noon, however, it had fallen to 29·646, at 4 P. M. to 29·454, at 8 P. M. to 29·218, at 11 P. M. to 28·656, and at midnight to 28·573, the lowest reading recorded. From 10 to midnight the wind was from the east, and then began to veer to the northward, from which quarter it blew with somewhat abated force but still with great fury at 3 A. M. on the 5th. The Barometer then stood at 29·252. By 4 A. M. the wind had got round to north-west, blowing as hard as at 3, and accompanied by heavy rain. By 6 it blew a close-reefed topsail breeze from the west, with a tremendous sea from west south-west, the clouds broken and flying in masses very fast and low, to the north-east. At 8 A. M. the Barometer had risen to 29·451, at noon to 29·617, at 4 P. M. to 29·654, and at midnight to 29·749. The wind blew fresh from west south-west from noon up to midnight, and then became very light. Captain Smart observes, that from 7 P. M. of the 4th "I did not observe a single flash of lightning, nor any thunder." This absence of lightning is a noteworthy peculiarity of the Cyclone, and was equally remarked in its passage over Bengal.

From the above, it appears that the *Chinsurah*, after leaving the Sandheads, ran down towards the advancing Cyclone, but a little to the west of the track; that she passed the centre about midnight of the 4th,

* This and all the other barometric readings of the *Chinsurah* are reduced for temperature.

or 1 A. M. of the 5th, and then keeping to southward gradually extricated herself from the storm without injury, after which she put about and ran up for False Point.

The *Foam* was less fortunate. Having slipped her cable at ½ to 4 P. M. on the 4th, she stood out to sea under a reefed foresail, and fore topmast staysail and fore staysail close-reefed, the wind blowing a strong gale with heavy squalls from the east north-east,* with a falling Barometer. At 8 P. M. it was blowing a violent hurricane from the east with a very heavy sea, the Barometer falling rapidly, till at 10 P. M. it stood at 28·45.† At 11, the quarter-boat was washed away, and the vessel thrown completely on her beam ends. The main mast was then cut away, which gave immediate relief. The Barometer stood at 28·10, at which it remained till midnight, the wind still blowing a furious hurricane from the east. At 1 A. M. on the 5th the wind was east north-east, undiminished in force. Half an hour later it veered to north-east, the Barometer fluctuating between 28·30 and 28·40, and at 3 the wind veered rapidly to the north, the Barometer standing at 28·40. At 4 it still blew a heavy hurricane, the wind having got round to west south-west, with a heavy sea, the Barometer at 28·50. The vessel then wore on to the starboard tack with her head to southward, and by daylight the wind had got round to south-west, and the storm greatly moderated, the Barometer having risen to 28·85. At 8 A. M. the wind was fresh from the south, weather cloudy, and a very heavy sea. The ship was then cleared of the wreck and bore up to the north, with a fresh south south-west wind, and weather rapidly clearing up. At 10 the Barometer stood at 29·40, at noon 29·60, the vessel being in latitude 20° 14′ north; wind moderate from south south-west. At this time the centre of the Cyclone was 140 miles to the northward, passing over Tumlook. At 4 the

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* The direction of the wind is given as east south-east throughout the day in the MSS. copy of the log before us, but this is evidently a clerical error.

† This Barometer appears to read about 0·28 lower than that of the *Chinsurah*. The observations are quoted unreduced, as no temperature observation is given in the log. If, in order to compare them with the *Chinsurah* readings, it be desired to obtain an approximate reduction, we may assume the mean of the temperatures recorded on board the latter vessel 85° for the night of the 4th, and up to 8 A. M. of the 5th, and 82½° for the 10 A. M. and noon observations. The observations of the *Foam* thus reduced will be—

10 P. M., 4th	... ...	28·306	3 A. M., 5th	... ...	28·257
11 „ „	... ...	27·959	4 „ „	... ...	28·356
Midnight	... ...	27·959	Daylight „	... ...	28·705
1 h. 30 m. A. M., 5th	...	28·158 to 28·257	10 A. M. „	... ...	29·259
			Noon, 5th	... ...	29·458

Barometer had risen to 29·70, and at 8 P. M. to 29·73, the wind light from south south-west and weather fine.

The *Foam* appears then, like the *Chinsurah*, to have scudded round to the west of the centre, but passed much closer to it than the *Chinsurah*, as is indicated by the difference in the minimum indication of their respective Barometers. After allowing for the instrumental error the lowest reading of the former was 0·34 lower than the latter. It is noteworthy that on board both ships the minimum reading was in advance of the centre, while the wind was still from the east, and that by the time the wind had veered to north the Barometer had risen 0·68 on the *Chinsurah*, and 0·30 on the *Foam*. Both ships had driven much to westward under the force of the gale, one, if not both, being, as we infer on the port tack. The two ships must have been within a few miles of each other at the time they passed the centre, notwithstanding that the *Chinsurah* had left the Sandheads nearly fourteen hours before her consort

The *Proserpine* was crossing the head of the Bay on the 4th October, and, notwithstanding that she was at no time within 180* miles of the centre, she experienced very heavy weather from the recurring southerly wind current, which was, as we infer, the chief cause and feeder of the Cyclone. For the varying directions of the wind experienced by her and the variations in her Barometer we refer the reader to the map Plate I. She experienced the first indications of the gale on the evening of the 3rd: on the morning of the 4th it blew a fresh gale from the eastward, with increasing sea, which, by 3 A. M. became too powerful for the steamer to make headway against, and after vainly attempting to progress by putting her head within five points of the wind, she drifted and steamed up to the west of north on about the course shewn in the map, the helm being totally unmanageable. For further details we refer to the log, which is given *in extenso* in the Appendix.

As affording a contrast to the experience of this ship, we may briefly quote the log of the *Nile*, the noon position of which, on the 4th, was about 20 miles nearer to the storm centre than that of the *Proserpine* but in a diametrically opposite quarter, *viz.*, to south south-east, and therefore within the influence of the recurving northerly current.†

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* The Captain of this steamer, Captain J. V. Falle, opined that he was not within 150 miles—a very fair inference.

† The greater fury of the storm on the north-east and east, here evidenced by the comparison of the log *Proserpine* with that of the *Nile*, is quite in accordance with subsequent more detailed experience of its passage over Bengal.

Tuesday, October 4th A. M.,—confused sea; ship pitching at times. Daylight, weather unsettled, wind north-west; a head sea. Forenoon, wind north-west, freshing at times; a north north-east sea. Noon, wind north north-west; weather cloudy; sea merry; P. M. squally with rain; sunset, wind west north-west; steering north. High north sea; we appear to be running into it. Midnight, moderate west breeze, ship plunging heavily to a high sea.

We have thus traced the progress of the Cyclone from the 2nd October, on which day we have the first indications of its existence, to the west of the Northern Andaman, up to midnight of the 4th, when the centre was in about the latitude 20° 20′ and moving northward at the average rate of 10 or 11 miles an hour. We have shewn that there is reason to believe that it was mainly generated by a stormy current originally from the west south-west and south-west, which was felt in Ceylon and Port Blair on the last two or three days of Septemtember, and began to curve in to the Cyclone on the 2nd October.

We have given our reasons for inferring that the first formed Cyclone was not permanent, but that the southerly current forcing its way up the Arrakan Coast, recurved and formed a second vortex about 280 miles to the north-west of the Andamans on the 3rd October, and that this (or a series of vortices consecutively formed and dispersed in like manner to the above) advanced at an average speed of 10 miles an hour up to the point above indicated at midnight on the 4th, whence the storm continued its destructive course over Lower Bengal. To the description of this further progress, founded on more ample data than we have for its earlier history, we now proceed.

PROGRESS OF THE CYCLONE OVER BENGAL FROM THE 5TH TO THE 7TH OCTOBER.

We have seen that, at midnight of the 4th, the position of the storm centre was a little north of the latitude of False Point, its course being almost due north towards Higellee, on the west bank of the embouchure of the Hooghly, nearly opposite to Saugor Point. The Floating Light Ship *Comet*, usually stationed at the lower entrance of the Eastern Channel, (better known as the Sandheads) had parted her cables half an hour before midnight, and was drifting before the storm in a

west north-west direction, the sea breaking over the vessel fore and aft, and washing away her starboard quarter-boat, while the gale carried away her awnings, booms, stanchions, fore-staysail and foresail under double gaskets. "The storm was then fearful" from the east north-east. At 4 A. M. the Barometer stood at 29·35,* the storm from the east as hard as ever. At 9 A. M. the gale was veering round to south-east, with little lulls, and the Barometer had risen to 29·46. At noon the storm was moderate and veering round to south and westward: Barometer 29·50. At 4 P. M. the vessel anchored, and on the following day found her position to be in 7½ fathoms in the South Channel in north latitude 21° 10′, east longitude 88° 02′, 15 miles to west north-west of the station.

The *Alexandra* steam tug was at anchor off Saugor Light House on the early morning of the 5th. It was then "blowing in heavy gusts from the eastward, with a heavy sea and constant rain. Barometer falling very fast." At 4 A. M. the wind shifted suddenly to north-east, blowing in furious gusts accompanied by pelting sleet and seas over all. "On coming head to wind, the engines were set going with seven revolutions, at full power; about 8 or 9 A. M. *it became suddenly calm* with a heavy confused sea, *the sun appearing* at the turn for a few minutes. Got the head of the steamer to northward, having only then discovered that the cable had parted. The frightful roar of the hurricane, the heavy sea breaking fore and aft, and the steamer lying on her beam ends, prevented anything being noticed with regard to the cable before." *The calm interval lasted about three quarters of an hour,* the steamer's head to wind and the engines doing their best. "During the calm, being apparently in the vortex of the hurricane, several land birds were falling about the decks, some dead. Got soundings in seven fathoms. Supposing the steamer to be still in Saugor Roads, kept on going to the north and east, but could sight no land; secured hatches, and at the end of the calm, a thick mist and heavy rollers seemed coming from north-west accompanied by a moaning sound, which was immediately followed by a sudden blast from the north-west, throwing the steamer on her beam ends, and burying her in a sheet of foam to the top of the funnel. The port jolly-boat blew on board and carried away the standard compass. The starboard one was under water, and was torn from the davits; all that could be done was to try and keep her near the wind,

* This Barometer appears to read about 0·10 lower than that of the *Chinsurah*, see p. 24, so far as the comparison of a single pair of observations admits of an inference. The readings are given unreduced.

while heading to northward, by means of the engines only, as it was impossible to think of letting go another anchor. After blowing till 2½ P. M. with the most intense fury and driving sleet, the wind shifted to the south-west; the weather broke suddenly, water became smooth, and land appeared on the port beam. Finding the vessel in 4 fathoms, made preparation to anchor; situation very doubtful and coast strange; 3 P. M., water suddenly shoaled to 2 fathoms; the steamer struck before the engines could be reversed, and in less than an hour was quite dry. About 9 P. M. as the tide made, backed off to the westward into smooth water, and anchored in 4 fathoms for the night." In the morning the position was found to be off the Piply Sands in Balasore Roads.

We have given this highly interesting account* nearly *in extenso*. It appears that while steaming full power against the wind, the ship had nevertheless drifted upwards of 30 miles to the westward, passing through the central calm, which she was three-quarters of an hour in traversing, and meeting the storm again on its south-western quarter. The centre had previously passed to the westward of the lightship, which could not (to judge from her barometric readings) have been within 10 or 15 miles of its track. The Barometer of the *Alexandra* was unfortunately broken in the storm, and we have thus no reading of the lowest pressure at the central calm. We obtained one, however, shortly afterwards in its passage over Contai. The *Phœnix* and *Dwarkanauth* tug steamers, also at anchor off Saugor, foundered. Of the crew of the former three were saved, of that of the latter not one. The *Hope* Light Ship at the Upper F. L. Station was lost with all hands.

The passage of the Cyclone over Bengal on the 5th is illustrated by the accompanying table, compiled from a large mass of information forwarded to us in private letters, and taken from published accounts. From the nature of the evidence, it can in great part only pretend to an approximative illustration of the varying changes in the wind, and the hours of change, but the evidence is amply sufficient to allow of a pretty accurate inference of the general course and rate of progress of the storm, and to give also, in conjunction with other details, which we shall extract from our materials, an indication of the comparative violence of the gale in different parts of Bengal.

We shall, in the following description, first of all trace the progress of the centre and then describe the phenomena to east and west of the track.

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* Extracted from the *Englishman* newspaper.

At Contai* it began to rain about 8 o'clock on the evening of the 4th, the wind being fresh, but not strong, from the north-east. The gale commenced at 4 A. M. on the 5th, and increased steadily up to ¼ to 9, when it was at its height. Between 8 and ¼ to 10 the Barometer (aneroid) fell from 28·95 to 28·025 (*see* Plate VI.), at which point it remained till 11, during which the centre of the Cyclone was passing over the station. At ¼ to 10 the wind 'lulled almost to a calm.' At 11 the storm recommenced, the wind coming from the south-west, and raged for an hour, during which it is described 'as a perfect whirlwind.' By 12 the Barometer had risen to 28·125, and shortly after, the gale was nearly west. By 2 it had moderated, and the Barometer had risen to 29·40. Mr. O'Flaherty remarks that the wind appeared to be most violent both before and after the passage of the centre when the Barometer stood at 28·50, *i. e.*, ¼ to 8 and ¼ past 12.

The centre of the calm thus passed over Contai at 23 minutes after 10, the aneroid shewing a depression of nearly 2 inches or a removal of nearly $\frac{1}{13}$th of the normal atmospheric pressure. The greatest violence of the gale appeared to be by no means immediately on the limits of the calm, but when (according to the calculated rate of progress) these were about 14 to 20 miles distant.† From the lapse of time (1¼ hours) during the passage of the calm, which exceeds that recorded at any other station on the track, we must infer that Contai was situate almost or quite on the central line of the track,‡ but it is noteworthy that the *general* track of the storm being due north, the wind immediately before and after the passage of the calm was north-east and south-west, not east and west, as we should expect, in accordance with the Cyclone theory usually adopted.

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* For information of the passage of the storm over Contai we are indebted to Mr. O'Flaherty of the Public Works Department. From the same gentleman also we have received through Colonel Short and Colonel Beadle much valuable official information respecting the destruction caused by the storm and storm-wave, which will appear in the proper place.

† This calculation is, however, open to question. The progress of the storm, as will be shewn in a subsequent part of the Report, was very irregular, and there is much reason to believe that its passage over Contai was very slow.

‡ We may here remark that from other observations we have some reason to infer that the course of the central calm is not steadily forwards in a regular straight or curved line, but reverging irregularly from side to side of the average track. It is not improbable that the calm may have halted for a short time over Contai, as may be observed in the motion of an eddy in a downward flowing stream of water.

A little after the passage of the centre over Contai the ship *Martaban*, drifted from Saugor Roads up the estuary, appears to have been close to the eastern verge of the calm. The log of this ship offers some remarkable observations, but exhibits, in some places, what appears to be a not uncommon clerical error, *viz.*,—north written for south, east for west, and *vice versâ*. The report of the Pilot, Mr. N. W. Vaughan, has, however, enabled us to correct these errors. We give a full abstract of the meteorological observations in the log, and in the Pilot's report, both of which documents are given entire in the Appendix.

* On the evening of Tuesday, the 4th, the *Martaban* was at anchor in Saugor Roads, experiencing a strong breeze with heavy squalls, wind from north-east by north. At 10 P. M. an increasing breeze from north-east, and constant heavy rain. Midnight, strong gale and rain. At 3 A. M. (Wednesday 5th), gale still increasing, east south-east to south.—4h. 30m. A. M. blowing pretty hard. Sent down royal and top-gallant yards; wind hauling to north-east. 'Gale increasing at the rate of two every quarter of an hour'.† 5 A. M., it began to blow a heavy hurricane, wind east by north; ship dragging her anchors.—7·30. Still increasing. 'It blew so hard by this time that the spray cut our legs and faces;' wind east ½ south. 8 A. M., still increasing 2; wind east by south. 8-30, wind south-east; 9-30, increasing 2. Jibboom gone and likewise the fore-royal and top-gallant masts. At 10, mainmast went by the board, carrying with it the mizen topmast; wind south south-east. 10-30, fore-topmast carried away; *wind south-east by south*, 10-45, *wind hauling as far as east north-east, stopping at that quarter, and then hauling round the compass as far as north-west by west. Barometer* 28·150.‡ 11-15, the ship moving, bringing the wind on her starboard side, where the wreck was lying. *Atmosphere brightening up.* 11-30, Barometer 28·35; the wind died 3. 11-45. Wind increased 6, blowing a terrific Cyclone. Soundings 3 fathoms.—12 (noon). The sea [storm] wave, we supposed, brought us 3 or 2½ fathoms more, as we had 5 fathoms shortly after-

* For this interesting log we are indebted to the 2nd. Mate Mr. Richard Nicholson through Dr. Partridge.

† The following explanatory note is given at the end of the log:—"8.—A moderate gale. All numbers in the remarks added to the previous number 8." These cannot be Admiral Beaufort's numbers.

‡ The readings in this log and the Pilot's report appear to be unreduced, and are unaccompanied by temperature observations.

wards. It carried our spars away, washing them on the cable, which we had to clear to pay it out. *Wind north-west* [south-east ?]—12-30. The decks were completely covered with mud and pieces of wood. *Wind north north-west* [south south-east ?]—1 P. M. Gale decreasing; Barometer 28·5.—3 P. M. Wind abated, leaving us a total wreck. Found we had dragged 17 miles across the banks at low tide, leaving us only sufficient water to float.—4 P. M. Barometer 28·870. *Wind gradually decreasing north-east* [south-west ?].

We have italicized in the above the more striking anomalies and errors in the observations. The peculiar shifting of the wind at 10-45, just before the lull in the storm which indicated the passage of the central calm, is remarkable, but we have no reason to question its accuracy. We can only explain it on the supposition of secondary vortices. The wind directions of the later part of the storm are totally inexplicable as they stand, but, as above remarked, the Pilot's report shows that they are erroneously written down. The following is an abstract of Mr. Vaughan's report:—

"On the 4th October, towed in from the eastern channel by the steamer *Phœnix* and anchored at 2 P. M. in the following position:—In Saugor roads; Saugor Light-house south-east by south. Cowcolly light, north-west half west. Upper Saugor flat buoy, east by south; in 9¾th fathoms water. The weather was squally from north-east, with heavy rain. Barometer 29·90, clearing up in the afternoon. Barometer rose to 29·95 at 10. Squalls from north-east, and rain continuing throughout the night.—1 A. M. of the 5th October. Barometer had fallen a little; squalls increasing in force.—6 A. M. wind had veered to east by south, increasing to a heavy gale. A heavy sea had set in, causing the vessel to pitch and knock about very much; Barometer now began to fall very rapidly; in an hour's time the mercury had gone down an inch.—8 A. M. Blowing with terrific fury from east south-east. Jibboom and fore topmast carried away, &c.; the mizen mast went close to the deck, taking with it the mizen topmast and head of mizen mast; the fore topmast likewise carried away.

"10h. 30m. A. M. Barometer 28·14, the lowest that it fell to.—11 A. M. A slight rise in the Barometer, wind veered to south-east, still blowing with great fury.—12 (noon). Barometer 21·35, wind south south-east. Twenty minutes after this the Barometer 28·85, wind south, and decreased in force.—2h. 20m. P. M. Moderate south south-west gale;

Barometer 29·41 ; rain had subsided, sea gone down, and weather clearing up rapidly. It having cleared up sufficiently for me to see the landmarks, I was astonished to find myself in the following position :—

Kedgeree House	south-west	¾ west ;
Mud Point „	east	¾ north ;
Gungra, T. S.	west by south	½ south,

and in 5 fathoms water, and, as far as I could judge, westward of the Jellingham sand : my astonishment was great to find myself here, having driven over some of the most dangerous sands in the river without bumping or shoaling my water. The lead was constantly attended to by myself ; a deep sea lead was used, and as well as I could judge, we never shoaled into less than 7 fathoms. In tracing the drift of the ship *Martaban* on a chart, I find that the storm-wave must at least have risen 40 feet to have carried me across these sands."

The minimum reading of the Barometer on the *Martaban* was, it may be observed, only 0·125 higher than that of Contai during the passage of the calm, and if reduced for temperature would be almost exactly the same. It, however, preceded the lull noticed in the log.

Cowcolly Light-house is situated about 13 miles to the east and 4 to the north of Contai and about 8 miles south south-west of the final position of the Martaban above specified ; from this place we have an account of the storm by the Light-house Superintendent, Mr. James Daniel, which is valuable as affording a datum for calculating the extent of the central calm.

"About 5 A. M. of the 4th, the wind commenced blowing a stiff breeze from north north-east, which continued the greater part of the day ; at the close of the day the wind fell and kept so till midnight, after which it increased again. At 3 A. M. of the 5th there was a dead calm, which lasted for an hour : after that it began to blow again in frightful puffs with a lull between. This lasted till day-light, when it began to blow very heavily from the north-east, with a driving rain, and at 7 A. M. it was blowing a hurricane, which increased in violence every moment ; about 9 A. M. a thick scud or spray obscured everything, so that I could not see anything around. A little after 10 A. M. there was a sudden lull, so sudden that I could hardly believe everything was still ; this was of short duration ; for, in the course of a few minutes, it was blowing

as heavily from the east,* the wind having shifted during the lull. It was at this time (10 h. 30 m.) that the storm-wave broke over the place, sweeping everything before it; this continued without any intermission until 3. P. M., when the wind moderated a little and suddenly shifted to the south-west; from this quarter it blew with equal fury till 4 P. M., driving a large quantity of water before it, with human beings and cattle intermingled. It was impossible to render any assistance at that time, but about 5 P. M., when it became quite calm and clear, and the water could be waded through with safety, although it was up to the waist and rushing with some force through the gaps in the embankment, I had the satisfaction of saving nine poor creatures who were clinging to the roots of upturned trees. ..... After 5 P. M. there was only a light breeze, still from the south-west, which continued throughout the night. The night was bright and starry."

From this it appears that the eastern verge of the central calm passed over Cowcolly about the same time as the centre of the calm was passing over Contai. It may have been a little later, for we cannot lay much stress on small differences or strict agreement of time in accounts which do not pretend to scientific accuracy. It is, however, interesting to note that the semi-diameter of the calm extended not less than 14 miles, if indeed we are right in assuming that Contai was on the central line. In any case we cannot but infer that the calm was of greater extent at this time than on the evening of the same day when it passed over Kishnagur.

The lull between 3 and 4 A. M. of the morning of the 5th is noteworthy, but the data are insufficient to admit of our suggesting any explanation of its cause.

The following extracts from an official report of Captain Laycock, Officiating River Surveyor, commanding the steam vessel *Salween*, give an account of the storm as experienced a few miles higher up the river than Cowcolly. The position of the vessel on the night of the 4th was near the Upper Eastern Mud Point Buoy at the northern extremity of Saugor Island.

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* Either the time or the compass points mentioned in this report must be erroneous, as is obvious on comparing them with those of the *Martaban* reports and those of Contai. Mr. Daniels was written to with reference to the above, and his answer will be found in the Appendix.

"Throughout the morning of the 4th the weather gave no warning of the coming gale, and the Barometer stood at 29·90. Towards noon it became cloudy to eastward. About 4 P. M. the Barometer commenced falling; at 8 P. M. it was 29·73.—10 P. M. Increasing squalls: at midnight blowing a gale at north-eastward, with rain and high sea getting up. 5th October at 3 A. M. blowing a hurricane; Barometer 29·49. At 6h. 30m. saw the Upper Eastern Auckland Buoy about 50 yards to north-east of us. Finding we were fast drifting on to the mizen sand in $2\frac{1}{2}$ fathoms, slipped and set the fore-topmast stay sail; got her head to westward, and steered for Kedgeree. At 7 A. M. took the beach opposite the Post Office, the Cyclone at this time blowing with terrific violence; the Barometer fallen to 27·90; the sea washing in immense waves over the vessel; sails all blown from gaskets, the boat washed away, and weather one blown up the main rigging over the davits.

"Observed that the storm-wave was carrying us in shore, as we passed over the tops of several trees. At 11 A. M. observed that the wind had veered to southward and eastward, still blowing in fearful gusts. At 1 P. M. observed the water to be falling, and saw the Deputy Post Master's house, about 100 yards astern of us. 3. P M. the water had receded from us; found the ruins of the Telegraph Office under our jibboom." The writer goes on to describe the destruction of the whole of Kedgeree village and bazar, &c., but we shall quote this in our subsequent description of the storm-wave, and its effects.

From Diamond Harbour, 30 miles north north-east of Cowcolly, we have three accounts, the best of which is that of Captain Lewis, at that time commanding the Government Hospital ship *Bentinck*. The following is compiled from his report, one or two details being added from the other accounts:—

At 10 P. M. of the 4th, the wind was north north-east, blowing in gusts with heavy rain. At midnight the wind was from north-east, and increased till day-light, when it was blowing a gale from east north-east with heavy rain throughout. At 7 A. M., the wind was east, blowing a heavy gale, and at 9 was from the south-east, increasing in force. At 11, the wind was south, blowing with its greatest violence, and at this time the great storm-wave struck the ship, lifting her with two anchors, and breaking the chain of the third. The vessel was then dipping bows under water; so much so, that she appeared to be going down head foremost, but she suddenly righted and was adrift. Previous to this, there

was an influx of water, and Captain Lewis had observed a large and deep country boat lifted over the point of land which is the site of the old Custom House. At the influx of the great wave the Custom House Sloop sank, the storm-wave rising over her and submerging her at her anchors, which she was not sufficiently buoyant to lift. The wave progressed from south-south-west to north-north-east. The height of the wave over high water mark spring tides, is estimated by Captain Lewis as not less than 25 feet, or 27 feet over the high water mark of the day.* The *Bentinck* was drawing 20 feet at the time, and was lifted over the river embankment 4 feet above high water mark. The time of high water was 10 h. 30 m., so that the wave came in half an hour only after the commencement of the ebb.

At 11 h. 30 m. the wind shifted suddenly to the south-west, driving the *Bentinck* on shore one mile to the north-east of her moorings, where she lay, after the retreat of the water. The storm-wave began to retreat about 1 h. 30 m., or 2 P. M. By 4 P. M. the gale had abated, and the wind was from the west.

At the Telegraph Office, it is recorded that the wave overflowed the bund about 11 or half-past, and at ½ to 12 the inmates had to take refuge, first in the upper story of the house, and then on the terraced roof.

Captain Lewis is of opinion that the central calm passed within a mile of Diamond Harbour, but this is probably erroneous.

† The *Kedgeree*, Pilot Vessel, anchored on the 4th a little below the Upper Rungafullah buoy, opposite Kulpee, (about 10 miles below Diamond Harbour). It was blowing a moderate north-east wind, with fine weather on the morning of that day; but during the afternoon the wind freshened, and on the morning of the 5th, it blew very fresh from the north-east. At 8 A. M. a fresh gale from the eastward. Barometer 29·87. "About 9 A. M. the wind shifted suddenly to the south-east, blowing a perfect hurricane;" one cable parted, and the ship began to drive before the wind, dragging the other anchor. At 11h. 30m. A. M. the vessel was lying hatches under, and so remained till at noon the mainmast was cut away, and the foremast followed, when the vessel sighted. At this time (noon) the Barometer stood at 28·54. At 1 P. M. the hurricane

* This is over-estimated, as will be shown in our subsequent account of the storm-wave.

† This account is an abstract of a report from Mr. Branch Pilot G. Noukes, commanding the vessel.

was at its height, the bowsprit was blown out of the vessel, the port quarter boat blew to pieces, &c. At 3h. 30m. P. M. the weather was clearing and storm slightly moderating, and by 4 P. M. it was moderating very rapidly, the Barometer had risen to 29·20, and the vessel was found to be off Hospital Point, 5 miles above Diamond Harbour, and more than 12 miles to north north-west of her position at the commencement of the storm. The Commander remarks that "our Barometer gave no indication of any thing extraordinary till the hurricane was on us, when it fell with unexampled rapidity. The sea was tremendous, and during my period of service, I have never experienced anything approaching to the force of the wind on this occasion."

The next station from which we have information* of the passage of the centre is Tumlook, on the banks of the Roopnarain, 37 miles north by east from Contai.

At this place "a steady gale"† set in from the north-east on the 4th, but did not increase perceptibly until 9 or 10 P. M. 'Between 3 and 4 A. M. of the 5th it was blowing from the same quarter, (or a little more easterly), but very heavily, until about 8 or 9 A. M. when it was blowing a hurricane from a little to north of east.' 'From this time until about half-past 11 the wind increased, and between 11-30 and noon the storm-wave came in, the water rising 13 feet after the wave had passed, and rising steadily until about *noon, when the centre of the Cyclone passed over the station:* at this time the wind was about due east. The centre [calm] was rather more than half an hour in passing, and then the wind came upon us due west, driving back the water. In two or three hours the wind perceptibly decreased, and by 6 P. M. it was only blowing a little fresh from the westward. The night and following day were fine and almost cloudless.'

Baboo Shama Churn Chatterjee reports (in an official letter to the Magistrate of Midnapoor) that when the storm-wave rose, the water stood 12 feet deep over the roadway of the Tumlook Bazaar. The gale and flood together levelled all the trees, and kutcha (mud and matting) houses, and many of the pucka (brickwork) houses. He states further, that out of 1,400 houses [and huts] in the station only 27 were left standing.

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* For which we are indebted to Mr. Haughton.

† Or rather probably a strong breeze, but landsmen do not attach the same precise meaning to words descriptive of weather as seamen do.

Eleven miles north by west of Tumlook (as measured by compass) is Koila Ghat, at which place the road from Calcutta (viâ Oolaburria) to Midnapoor, crosses the Roopnarain river by a ferry. From this point we have a very graphic account of the passage of the Cyclone by Mr. J. P. Grant, who was delayed here on his way to Midnapoor, and only narrowly escaped with his life. The hours after the arrival of the storm-wave are only given by estimate, and must, we think, be erroneous, the lapse of time before the passage of the calm being considerably over-estimated, as is not unnatural, considering the circumstances under which the writer was placed. We here give only an abstract of Mr. Grant's letter, which will, however, be found *in extenso* in the Appendix.

Mr. Grant started from Oolaburria about 10 P. M. by palki dak. About 2 A. M. it began to blow in heavy fitful gusts from the north, so strong that the torch could not be kept alight. This and the bad weather so retarded his progress that he reached the bank of the Roopnarain at Koila Ghat only at 6 A. M., having been 5½ hours travelling six miles. On reaching the ferry he found it impossible to cross, the river being so rough that the ferry boat could not have lived in it, even had it ventured to attempt the passage. He therefore repaired to a mud hut about 50 yards distant. From 6 A. M. to 10 A. M. it blew hard from the north; at 11 the wind was due east. "A few minutes after 12 there was a most curious sound in the air, exactly like the letting off steam from a steamer, but on a gigantic scale; and then the Cyclone burst in all its fury. ..... Soon after ..... the water (of the river) all at once suddenly rose, as if by magic, and slowly rolled towards us. The top of the wave appeared to be only 2 or 3 feet lower than the top of the bund.* The people then seized me by my two arms and dragged me out of the ruined hut, but directly we were away from the protection of our windward hut, we were laid flat on our backs by the wind. Finding it impossible to make head against the wind, we sat and laid on the road, forced to await the approach of the water. ... The water reached us exactly at 10 minutes to 1, at which hour, being up to my waist, my watch stopped. The

* "Both banks of the Roopnarain are provided with a high bund or embankment for the protection of the country in the annual floods. There is a partial break in that of the left bank, where the Oolaburria road descends to the river. Through this, the water poured over the surrounding low land to a depth, as estimated by Mr. Grant, of 3 or 4 feet, but did not cover the road, which is on the top of a high embankment."

water, however, carried us sideways into our old hut in its fall over the road embankment, and to three old hut poles and to two cocoanut trees that were near, we clung for dear life, up to our middle in water, for two long hours or more. ... At about half-past 2, however, the wind suddenly moderated, and we waded back on to the high part of the road." By this time it was a perfect calm. The sun-shone at intervals. During this calm, which must have lasted for about an hour, Mr. Grant made his way to a pucka house, at about ¾ mile distance, by wading through the water up to the armpits. He had hardly been a quarter of an hour in the house when the storm began again, this time from the west. It blew worse than before for about two hours, after which it gradually abated, and by 6 P. M. there was only a strong west wind. The following day was hot and cloudless.

The above abstract contains one or two corrections and additions to the original letter, which have been personally communicated by the author. But he is unable to offer any suggestion that would reconcile the apparent anomaly of the central calm not reaching Koila Ghat until nearly two hours after it had reached Tumlook, which is only 11 miles to the south, while its average rate of progress was about 14 miles an hour. Even had the rate been only 10 or 11 miles an hour, which was that of its passage up the Bay, this would bring the calm to Koila Ghat a little after 1 o'clock*, or only a quarter of an hour after Mr. Grant's watch had stopped, but we can scarcely imagine that, even in his precarious position, a lapse of a quarter of an hour should have seemed an hour and three quarters. The information we possess as to the subsequent progress of the storm does not help us materially to an elucidation. It is true that the barometric minimum at Calcutta was at 2-15 P. M., but we have seen in the case of the *Martaban*, that this minimum does not necessarily indicate the actual passage of the centre, and that on the eastern limb of the storm it was somewhat in advance, and we have no accurate track of the calm between Koila Ghat and Santipore. On the whole, therefore, we think that the most probable conclusion is that the progress of the calm was irregular and very slow between Tumlook and Koila Ghat, so that it did not reach the latter place until between 1 and 2 P. M. That it lingered over Koila Ghat is also probable, as Mr. Grant estimates its duration at not less than an hour, on pretty good grounds. While it lasted he had to wade over

* Mr. Grant assures me that his watch was correct by Calcutta time when he started on the previous day.

paddy fields, up to his armpits in water, to a village situated half a mile off the road; he then had to make his way over the masses of fallen trees which encumbered the village roadway, and he reached the house, in which he experienced the latter part of the storm, ten minutes or a quarter of an hour before it again burst upon him.

It may be noted that, as experienced by the *Alexandra*, the sun came out during the passage of the calm, a fact at variance with general experience in Cyclones.

The central calm reached Santipore, 66 miles (by compass) north by east of Koila Ghat, at 5 P. M., which, (assuming that it reached Koila Ghat at 1-30, or an hour earlier than the time surmised by Mr. Grant,) implies an average rate of progress of 19 miles an hour. Between these places we have no record of its passage. But the following data, from stations situated at no great distance to the eastward, may aid us in tracing its progress in the interval. We shall first describe the passage of the storm in full detail, and subsequently revert to the discussion of the inferential results.

At Calcutta the Barometer fell steadily and rapidly from 8, P. M. of the previous evening. The night of the 4th was dark and stormy, the wind blowing, at intervals of a few minutes, in strong and increasing gusts, varying from 3½ lbs. at midnight, to 5 lbs. at 3 A. M. After this hour it rapidly increased in force to 7 lbs., and at 5. A. M., to 10, 12 and 16 lbs. to the square foot. At 6 there was a violent squall of 24 lbs., after which the force did not materially increase up to noon. From 10 P. M. of the 4th to noon of the 5th, the mean direction of the wind was from east-north-east or east by north, varying, however, from two to four points at each squall. The wind was accompanied with driving but not heavy rain, and a low, thick, fleecy scud driving across the dull grey mass of the sky. By 6 in the morning the Barometer had fallen to 29·601*, (the minimum of the previous afternoon being 29·734,) and it continued falling with great rapidity, the mercury falling and rising distinctly with each squall,† so that at noon it stood at 29·113 inches. At 11 or 12 the trees began to fall before the force of the wind, even among the houses of Chowringhee, where they were comparatively sheltered. The wind at noon was due east, (or according to the self-registering anemometer east

* The barometric observations in this account are all reduced for temperature.

† This was more marked in the aneroid, the indicator of which was in almost constant motion, clearly perceptible to the observer. It fell *before the squall came on*, and the lower, the stronger the squall.

south-east). From noon to 2h. 45m. P. M. (the time of barometric minimum) it veered round gradually to south-east, the force of the squalls increasing up to 32 lbs. to the square foot at 1, at which time the self-registering Anemometer at the Surveyor General's Office was broken: shortly afterwards it was blown away.* At 2h. 45m. the Barometer stood at 28·570, and then rose even more rapidly than it had fallen, the wind veering round to south at half-past 3, and to south-west at 4, south-west by west at 5, and to west at 8. The force of the storm was greatest about the time of the barometric minimum, and abated more rapidly than it had risen, so that by half-past 4 or 5 it had gone down sufficiently to admit of many persons venturing across the maidan down to the river bank to see what had become of the shipping. No thunder or lightning were observed during the Cyclone; but in the evening a lurid light was observed in the north, which we shall find afterwards described more fully by other observers, and which we cannot but regard as an electrical phenomenon.

At Konnugur,† about 9 miles north of Calcutta on the opposite bank of the river, the evening of the 4th was cloudy and showery. At 6 next morning it was raining, with moderate force, and the wind was rather high from the east north-east. About 11 the wind began to increase in violence. At 12 it became a storm, and the direction changed to east. About half-past 2 the wind was from the south-east. The rain continued to pour on until about 4, when it ceased partially, but the storm increased in violence, the direction of the wind being due south. About 5 the wind was south-west, and half an hour later its force began to abate. By 6 the wind was from the west, and storm rapidly abating.

At Barrackpore (14 miles north of Calcutta and 5 from Konnugur) the weather of the evening and night of the 4th was similar to that at Calcutta. At 9 A. M. on the 5th it began to blow hard, and by noon became a hurricane, increasing in force until about 3 P. M. when the storm was at its height, after which it gradually abated; and by 6 P. M. it was over, the wind having died away. The barometric curve (aneroid) for Barrackpore is given at Plate VI. The wind was from north-east at a quarter past 2, and

* The instrument is one of Osler's construction. The vane was elevated feet above the building on an unsupported hollow rod, and was therefore not calculated to bear the enormous strain of the wind, which bent many of lightning conductors (of 1 inch iron rod) of the Howringhee houses double. The Anemometer has since been repaired and improved by being furnished with supports and friction rollers.

† Abstract from a letter in the *Englishman* newspaper.

had veered round to east by quarter past 3; by a quarter past 4 it was south-east; at 5 south-south-east, and south at half past 5. By 9 P. M. it blew lightly from the west. The barometric minimum was from 3h. 25m. to 3h. 30m. It appears to have been 0·26 lower at Barrackpore than at Calcutta, but as the Barrackpore instrument was an aneroid, and has only been corrected by the standard for the small range of an ordinary daily variation, we are unable to determine how far this apparent difference is reliable.

From Hooghly, 24 miles north of Calcutta and 10 from Barrackpore, we have two accounts,* both by good observers. They tally as closely as could be expected under the circumstances, except in the barometric readings, and especially agree in the statement that the greatest force of the wind was between 2 and 3, or half-past 3, which was, as we have seen, the time of maximum intensity at Calcutta. We give both accounts in *extenso*.

Mr. Baker writes:—"From sunrise to noon of October 5th, a strong north-easterly breeze, increasing to a fresh gale with heavy rain. Noon. Barometer 29·63,† blowing a heavy gale with strong gusts, and hard rain and sleet; wind veering to east north-east.—2 P. M. Barometer 29·32. Blowing a hurricane from east south-east, glass falling rapidly. At this time houses, trees, &c., were being levelled in all directions, and boats drifting ashore on the west bank of the Hooghly, which was giving way in many places from the heavy wash of rain.

"From 2 P. M. to 3¼ P. M. the Cyclone, blowing from east south-east to south, was at its height, but unfortunately, owing to the Barometer being in the Magistrate's house, adjoining my own, and all communication at this stage being impracticable, my next reading was deferred to 4 P. M., when the Barometer stood at 28·71 with a concave surface. This was the last reading, till much later in the evening, when it had risen an inch. The hurricane was unaccompanied by thunder, lightning or hail, which I have always experienced in violent Cyclones in other parts of the world; but the blasts of wind came at intervals with distinctly felt shocks, the roar of which could be heard some seconds before experiencing their full force. At 5 P. M. the violence of the Cyclone had somewhat abated, and the rain had decreased considerably. The wind

* Mr. C. G. Baker and Mr. Thwaytes.

† Unreduced, as also are all the barometric observations in this and the succeeding account.

was at this hour nearly south-west, the Cyclone having completed its 16 points in seven hours, and the 6 points from east south-east to south in one and a half hours, at which time we must have been nearest the centre."

Mr. Thwaytes' account is as follows; it was written at our request about a month after the storm, and is entirely from recollection :—

"10 A. M. Barometer 29·620, Thermometer 78°; wind north-east.—2 P. M. Barometer 28·730, Thermometer 78°; wind east; mercury falling rapidly. This reading was taken under great difficulties, but I think it is tolerably accurate. After 2 o'clock I had no access to the Barometer till between 4 and 5, when the reading was the same as the last, the mercury rising, and the wind had veered to the south. It is my impression that the greatest violence of the storm prevailed here between 2 and 3 P. M."

At Kanchraparah station, 4½ miles east north-east from Hooghly, we obtained the following brief note from the Station Master, given on recollection about six weeks after the storm :—

"The wind was from east south-east, blowing very strong up to 4 P. M. (5th). The gale then lulled, but there was no calm, the wind blowing only with less force. This lasted about an hour, during which the wind veered round to west south-west, and then began again with as great force as before."

It is impossible to reconcile the above accounts with any supposition of a regularly progressive storm, but our data are too imperfect to be worked out to any quite satisfactory conclusion. Between the times of barometric minimum at Calcutta and Barrackpore there is a difference of three quarters of an hour, the distance by compass measurement from station to station being 14 miles. According to this, the storm's rate of progress would be 17½ miles an hour, if the track were at the time due north. If at all inclined in any other direction, it must have been even greater. But we have seen that between Tumlook and Koila Ghat, only a few miles to the southward, its rate of progress did not exceed 6¼ miles an hour at the utmost, and if we take Mr. Grant's estimate of time, it was only 4⅛ miles. So far the facts would only prove great irregularity of movement. But it may be further observed, that the changes in the wind at Hooghly were contemporaneous with those at Konnuggur 15 miles to the south, and in advance of those at Barrackpore 10 miles to

the south. It would scarcely be safe to place much reliance on a comparison of the barometric readings at the two latter stations, but we may remark that, notwithstanding the very rapid rise of the Barometer during the two hours succeeding the minimum, (see Plate VI,) the Barometer at Barrackpore indicated a pressure of 0·3 lower than that of two different Barometers at Hooghly, at 4 o'clock. As, at both stations, the Barometer was rising, and the average track of the storm was nearly parallel to the compass direction of the two stations from each other, so that the vortex must, in any case, have passed Barrackpore earlier than Hooghly, we cannot but think that we have here very strong evidence that a new vortex was formed somewhere in the neighbourhood of Hooghly shortly after the centre of a previous vortex had passed over Koila Ghat. Such a supposition would be entirely in accordance with the barometric indications at Calcutta and Barrackpore; Barometers at these places would be affected by the northern as well as by the southern vortex, and instead of indicating a passing centre would indicate that of a mean minimum pressure between the two vortices. We cannot but think that this is a more probable explanation, than that of a single vortex being supposed to move with the velocity of at least 17½ miles an hour, immediately after, as shewn by the comparison of the Tumlook and Koila Ghat data, it had progressed at the rate of, at the utmost, 6½ miles. Again, if we take the whole compass distance between Koila Ghat and Santipore, where we next decidedly meet with the central calm, 66 miles, we find that the average rate of progress was 17½ miles an hour throughout; yet from Santipore to Kishnagur its rate of progress was not greater than 9 miles an hour, and was probably even less.

That such was really the case would further appear from the information, kindly obtained for us by Mr. Power, the Chief Engineer of the East India Railway, as to the changes of the wind at the Railway stations on that line.

The information was collected a few weeks after the Cyclone, and is not indeed to be relied on in detail, but the extract given below* from a tabular report forwarded to us by Mr. Denham, may, we think, be

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* The following is an extract from the tabular report drawn up by Mr. Denham, C. E. In a letter, enclosing the report, he remarks:—"I have made personal enquiries as to the direction of the wind at the several places pointed out as doubtful by Mr. Blanford, [in the report first forwarded]. I have also made enquiries as to the occurrence of any lull in the

accepted as showing that the wind veered in opposite directions at the stations of Mugra and Pundooah, 8½ miles apart, and that there was a lull of about an hour at the former station, *viz.*, from 2 to 3 P. M.; the time of the Calcutta maximum. This site of the centre had previously been ascertained approximately by one of ourselves from personal observation of the direction of the fallen trees in the neighbourhood of the line. The only place at which we noticed some lying to due east and others to due west was between Mugra and Pundooah for a mile or two near the latter station.* If the time given by the Station Master

storm at several of the stations. The information thus gained I have entered on the statement, which I return. I still think that with regard to the time it must be taken as merely a rough approximation."

Miles from Howrah.	Commencement of Storm.		Greatest violence of Storm.		Abatement of Storm.		Remarks.
	Time.	Wind	Time.	Wind.	Time	Wind	
12 Serampore ...	10 30	N. E	13 30	S E by S.	17.30	S. W. by S.	Lull from 15·30 till 16
15 Biddabatty ...	10 30	N. E.	13 30	S. S E	17.30	S W.	
20½ Chandernagore	9	N. E.	14	E.	16 30	W.	Lull for ¾ of an hour about 17 o'clock.
23½ Hooghly ...	10	E.	14	S E	16 30	S. W.	
29 Mugra ...	10	N E	15	N N. E	17	S. W.	Lull from 14 to 15. This was not mentioned in the first report]
37½ Pundooah ...	11 30	N. N E.	16	N by W.	17 30	S. W	
43¾ Boinchee .	11 30	N E by N.	16 30	N by W	17.30	S W.	

* Mr. Horne of Benares also made some observations on the direction of the trees by the side of the line. They differ somewhat from our own, so we give an extract from them below —

Miles from Howrah.		
	Howrah	from S.
6½	Bally	„ S. E. by E.
9½	Konnugur	„ S. E.
13	Serampore	„ S. E. by N.
21½	Chandernagore	„ E.
24½	Hooghly	„ N. E. by E.
34		„ N. E. by E.
37		„ N.
40 to 43		„ N., but a few large trees, E. and from N. E.
45	Boinchee	„ N.

at Mugra be not very erroneous, his information must be decisive; it is quite in conformity with the observations of Messrs. Baker and Thwaytes, but would show that the centre of a vortex existed in the immediate neighbourhood of his station at the very time when, according to Mr. Grant, another was passing over Koila Ghat. It can only not be accepted as decisive, owing to the doubt which, as Mr. Denham remarks, must attach, in some degree, to all the information he had collected.

From Santipore we have a good account of the passage of the central calm by Dr. Okhoy Chunder Roy, for which we are indebted to Dr. Partridge. The wind blew from the east on the morning of the 5th, but with no great force. It gradually increased till noon, when it was blowing strongly, accompanied by copious showers of rain. In the afternoon it became a regular storm, continuing to blow from the east till 3 P. M., when it changed its direction to north-east. About this time it was at the height of its violence, and the largest banyan trees were felled. The violence continued up to 5 P. M., when the storm ceased altogether, and there was a complete lull for about three-quarters of an hour. "The wind (then) again commenced, blowing directly from the west, and continued in the same direction until 11 P. M., then it again changed its direction, blowing from the south-west for about an hour, and it then ceased altogether." The writer observes, "I personally observed these changes, so that there is no mistake about them."

From the station of Buggoolah on the Eastern Bengal Railway, 11 miles due east of Santipore, we obtained the following notes from the Station Master, Engine Drivers, and others, on a personal visit a few weeks after the storm :—

The wind blew from north-east all day until half-past 3, and then went round to east. Between 6 and half-past 6 it shifted to south-east, and was then at its worst. It then veered to south and finally to south-west, and at 10 was quite calm. No lull or pause in the storm was observed at this or any other station on the line, with the exception of Kanchraparah, as already noticed.

From Moisgunj Factory, 6 miles due west of Kishnagur and 1 mile from the place where the Jellinghee falls into the Bhagiruttee, opposite Nuddeah, we have the following valuable observations by

Mr. T. Savi, which we give *verbatim*. The Barometer is a mercurial instrument by W. Harris, London, and, Mr. Savi assures us, a very good one :—

"7	A. M.	Blowing fresh from north-east, with rain.
9	,, ,,	Thermometer 81½°, Barometer 29·70.*
10	,, ,,	Blowing half a gale with strong gusts at intervals.
12½	P. M.	Gale increasing with rain. Barometer falling, 29·60,* Thermometer 82°.
2	,, ,,	Rain and wind increasing. Barometer 29·40.*
3½	,, ,,	Barometer 29·30.* Gale increasing.
4½	,, ,,	Very heavy rain. Gale increasing. Barometer 28·96.*
5h. 10m.	,, ,,	Barometer 28·90.*
5h. 20m.	,, ,, ,,	28·80.*
5h. 40m.	,, ,, ,,	28·70.*
5h. 50m.	,, ,, ,,	28·60.*
6	,, ,, ,,	28·50.*
6h. 30m.	,, ,, ,,	28·36.* Cyclone. The wind veered round to north-west; a lull of a few minutes.
7	,, ,,	Cyclone moderating. Barometer rapidly rising.
11h. 30m.	,, ,,	Barometer 29·40.* Gale abated.
12 midnight.		Barometer 29·50.*

It blew rather fresh from the south-west during the remainder of the night. Fall of rain during the 5th 7½ inches. Until the wind shifted at 6½ P. M. of the 5th, the prevailing direction was north-east. It did not blow so heavy from the north-west. The Barometer at 9 A. M. of the 6th was 29·82.*"

From Kisnaghur our information is less reliable. It was collected from the residents by Dr. F. Earle about three weeks after the Cyclone, and communicated in a letter to Mr. Heeley. The writer was not in the station at the time, but in a boat, which was wrecked in the Hooghly, not far from the station of the same name.

"5th October.—Morning stormy; wind and rain. Wind east north-east; towards evening wind increased. From 5 to 7-30 it blew quite a hurricane. Very heavy rain. A lull (some say lasting half an hour,

* These observations are all unreduced.

others an hour) commencing at 7-30 and lasting 30 or 40 minutes. The wind then blew with almost equal violence from north-west, accompanied by less rain than in the morning. Ceased altogether at 9-30 P. M."

If the position of the four last-mentioned places on the map be considered together with the general track of the storm, it will be seen how difficult it is to reconcile the time given in the Kishnagur account with those from Buggoolah and Moisgunj, which are pretty consistent with each other, and indicate that the centre passed over Kishnagur about an hour earlier than the time mentioned by Dr. Earle. As, moreover, the latter information is taken from the general recollection only of those who were on the spot, and as there is the great discrepancy noticed by Dr. Earle in their reports, while Mr. Savi's observations at Moisgunj are evidently given from actual careful observation made at the time, we think that it is safer to regard the Kishnagur report as probably erroneous, than to attempt to deduce any anomalous storm course and rate of progress from the difference of the hours.

The storm centre reached Mehurpore, 28 miles north north-east of Kishnagur, at 10 P. M., causing, as at Moisgunj, a few minutes' lull, followed by a change of wind to north-west, which indicates that, like Moisgunj, Mehurpore experienced the passage of the western verge of the central calm. We have the following account from this place by the Assistant Magistrate of the station. The official report from which it is extracted gives a valuable account also of the destruction caused by the Cyclone, which will be noticed in its proper place.

On the 5th instant the day commenced with heavy showers; wind east north-east; at 11 A. M. blowing a strong gale, with incessant rain; at 4 P. M. the storm increased; the wind became more violent, and darkness set in; at 6 P. M. very heavy rain fell; from 8 to 10 P. M. the storm blew a hurricane. At 10 P. M. there was a few minutes' lull, when the wind shifted a few points, and setting in from the north-west blew with increased fury for about an hour and a half, when it began to subside.

From Moisgunj Factory to Mehurpore the distance is 30 miles by compass, and there is difference of $3\frac{1}{2}$ hours between the occurrence of the lull at the two places, giving an average progress of $8\frac{1}{2}$ miles an hour. The distance of Santipore from Moisgunj (measured on the storm track)

is 9 miles, and the middle of the calm passed the former place 1 hour and 5 minutes before the lull at the latter, giving a rate of 8¾ miles in the hour. We may therefore infer that the centre moved at a pretty uniform rate from 5 to 10 P. M., a dictum which we shall find of value in enabling us to calculate the size of the central calm.

Beyond Mehurpore we have no information of the passage of the centre until we get to the north of the Ganges, and here again we meet with a mass of apparently discordant data, which, after making all due allowances for probable error, we can only reconcile with the assumption, (supported moreover by the observations at other stations,) that a new vortex was formed in the neighbourhood of the Ganges on the evening and night of the 5th, which then swept forward at a moderate rate over the stations of Nattore and Bograh. Before proceeding to describe its further progress, we will complete the record for Bengal south of the Ganges and the Bay by an account of the storm as experienced to right and left and to rear of the main track. We commence with the stations to the westward.

The storm had passed over Balasore during the night of the 4th, as already noticed at p. 22; at sunrise on the 5th the Barometer stood at 29·450. At 10 A. M. it was still blowing a moderate gale from the north-west, the Barometer being 29·550, and the temperature of air 82. Wet bulb 78. At 4 P. M. there was but a moderate breeze from the north-west, the Barometer stood at 29·610. Temperature of air 81. Wet bulb 77. The slowness with which the Barometer rose is remarkable, as it did not reach 29·845 until 10 A. M. of the 6th, and 29·900 till the same hour on the 7th.* There was no great destruction at Balasore, and the storm was not felt beyond about 20 miles to the south-west of that station.

Mr. Bailey of the Electric Telegraph Department writes:—"The gale was felt as far south as Balasore, but the first mark of its violence that I came across, was an uprooted tree near the 17th mile-post from Balasore on the Midnapore road. At Jellasore and Dantoon, 31 and 40 miles from Balasore on the same road, the storm raged with great violence, tearing up the strongest trees and unroofing nearly all the huts. There were the same marks on the 36 miles between Dantoon and Midnapore, but between the

* The above information is from Dr. Jackson, the Civil Surgeon of the station.

latter station and Oolabaria there was evidence of the storm having raged with greater violence than in any part to the south."

At Midnapore* "the morning of the 4th October was close and cloudy. Towards the afternoon a chilly damp breeze sprang up from the north-east, bringing with it heavy low hanging clouds. At 11 P. M. the night was dark, the air perfectly still, and small rain was falling. At about 2 A. M. of the 5th a fresh breeze sprang up from the north north-east, which soon stiffened into a storm, blowing in strong gusts, and accompanied with rain. About 7 A. M. it veered round to north and assumed the character of a hurricane. Between 8h. 30m. and 10h. 30m. A. M. it raged with its greatest intensity, blowing in furious gusts, and attended with heavy rain. Branches were broken off trees and thrown to a distance; windows and doors were either blown in, or smashed; the thatching of houses was carried away, and trees, large and small, (some 30 and 40 years old,) were uprooted. The hurricane began to subside about 11 A. M., and at 2 P. M. it was blowing a stiffish breeze, accompanied with little rain. The rain ceased at about 3 P. M., and heavy low hanging clouds were being rapidly carried away to the south-east. Between 9 and 10 P. M. a light wind had set in from the south-east, and there were left only a few detached white lofty clouds. The fall of rain during the hurricane was 4½ inches."

It is noteworthy that whereas Midnapore is almost on a parallel with Tumlook, with respect to the track of the storm, that the violence of the hurricane at the former place was over, an hour before the central calm reached the latter.

An account of the storm, as experienced at the Amlaparah Factory near Ghurbeta, about 45 miles west of Burdwan, and 29 miles north of Midnapore, was published in the *Englishman* newspaper shortly after the occurrence. It is to the following effect:—

"At 3 A. M. of the 5th there was a moderate breeze and rain, both increasing up to 8 A. M. At 9 the wind was from the north-east; rather a lull: at 10 it was blowing hard, with rain, from north-east by north. At 10h. 30m. raining fearfully hard and blowing in the same manner, from the same quarter as before. At 11h. 15m. the wind was

* This account is taken, with slight verbal alterations, from a memorandum by Dr. E. C. Bensley, forwarded by the Magistrate of the station to the Asiatic Society.

from the north, blowing very hard. 11h. 45m., blowing harder than ever. Noon, blowing very hard, with fearful gusts. 12h. 40m. blowing harder than ever. 1h. 30m. P. M. wind still increasing. 2 P. M. blowing the hardest. 4 P. M. a moderate gale with slight rain. Four miles to the north-west there was only a moderate breeze the whole time, and 10 or 12 miles beyond that in the same direction, but little rain or wind, and the same to the west. A little to the eastward some trees and *kutcha* houses were blown down, but to no great extent." Amlaparah was therefore beyond the destructive range of the gale, and the force of the storm was apparently not greater than that of an ordinary north-wester.

At Burdwan,* the sky, on Tuesday the 4th, was overcast, and there was a light breeze from the north-east. On the Wednesday morning it blew fresh, (apparently from the same quarter,) with rain, and by 10 A. M. it was blowing a gale still from north-east. By noon, the wind had veered to north, and from that time it blew a hurricane, gradually veering to north north-west. After this the storm gradually subsided, and by 9 P. M. it was over. During the night the wind shifted to south-west, and on Thursday morning every thing had resumed its usual serenity. The rainfall is stated to have been from 4 to 6 inches. A few large trees were blown down at the eastern extremity of the station, but on visiting the place about a week after the storm, when the trees of Calcutta were bare of leaves, we found no very perceptible traces of violence, beyond that mentioned above, and the trees and shrubs were covered with foliage.

The report of the Railway Station Master is to the effect that the storm commenced at 12h. 30m., the wind being from the north. Its greatest violence was at 4 P. M., when the wind was north north-west, and it abated at 7 P. M., with the wind from north-west.

The Khanoo Junction is 7½ miles west north-west from Burdwan. From this place Mr. Cockburn, C. E., sends the following account, for which we are indebted to Mr. Power.

"The gale did not extend further up the line than about Paneeghur and Bulpore, and no damage was done by it in the Ranigunge district, except some Telegraph posts bent between 73 and 74½ miles (6 miles beyond Burdwan), some pieces of decayed fencing blown down, and a

* This account was published in the *Englishman* newspaper.

few thatched roofs of sheds partially torn off. The violence of the wind at the junction was so great that I was much surprised at so little mischief being done by it. ..... The wind commenced on Tuesday night the 4th, and increased in violence through the whole of the 5th, abating in the evening. It began to blow from the north-east, and veered round by north nearly to west. The strongest wind blew from about north-west between 3 and 5 P. M. on the 5th."

At Ranigunge, 110 miles north-west by west from Calcutta, the storm was not felt, but the changes of wind during the day are somewhat remarkable. Mr. Vigors, C. E., writes :—

"The morning was fine, with the wind at north. About 9 it began to rain a little, and continued to do so at intervals till about 3, the wind having in the mean time shifted to north-east, but at no time was the rain or wind very heavy. By 5 the wind was east and decreasing in force, and at 6 it had fallen to a gentle breeze."

It seems remarkable that while at Burdwan and other places on the western limits of the storm, the wind should have veered from north-east round by north and west to south-west, at Ranigunge the change should have been in the opposite direction from north to east. We have been assured personally by Mr. Vigors, that the changes were strictly as above given, so that the apparent anomaly is not due to the common clerical error which we have more than once referred to.

At Sooree,* the same compass distance from Calcutta as Ranigunge, but in a north-west direction, and 75 miles from the mean central track of the Cyclone, there was a strong wind and some rain, but nothing that could properly be termed a storm. "On Tuesday evening, 4th, there was a cool pleasant breeze from the north-west, and on the following morning the sky was lowering, from which rain began to fall at about 9 A. M. The wind was at first easterly, and towards evening from the north."

Berhampore is 108 miles north of Calcutta, and about 40 miles from the Cyclone track, which a perpendicular line from Berhampore would intersect a little north of Mehurpore (see p. 46). From this place we have a good account by Dr. Fleming.

* This account is abridged from a newspaper report, and is confirmed by Mr. Verner of the Civil Service. The rain was, as Mr. Verner informs us, quite insignificant in amount.

On the 4th the sky was cloudy, with occasional showers from the eastward, with thunder. At 4 P. M. the Aneroid stood at 29·70, Thermometer 84°; Berhampore being 76 feet above sea level. At night a drizzling rain, with moderate wind from the east, set in. At daybreak on the 5th there was a thick driving mist, with a strong easterly wind, blowing in gusts. By 7 A. M. the mist had changed into a heavy rain, the wind at the same time increasing. As the day advanced, the rain continued, and the wind gradually veered round to northward and increased in violence. By 7 P. M. it was north north-east. By dark it was nearly north, and blowing in gusts with heavy rain. It continued to increase in force till about 10 P. M., when it was from the north-west. From this time it gradually subsided. At the time of its greatest force it was not stronger than an ordinary equinoctial gale, so common at the breaking up of the monsoon, and it did but little injury beyond blowing down a few trees and native huts, and sinking some country boats. The trees blown down were all lying from north north-west to south south-east. At daybreak next morning the wind was due west. The Barometer (aneroid) readings for the day were as follow:—

At 6 A. M. 29·78.
„ 10 A. M. 29·69.
„ 4 P. M. 29·47.
„ 10 P. M. 29·30.

At 6 A. M. of the 6th the reading was 29·63. The fall of rain during the two days, 4th and 5th, was 3·43 inches.

"At Rampore Hât,* 30 miles west and a little north of Berhampore, it was blowing rather fresh during the day with heavy showers, but the wind was not so strong as to attract particular notice. The prevailing wind was from the north-east, and it blew stronger between 9 and 11 P. M. than it did during the day. Between 5 and 7 P. M. it was quite calm. The wind commenced again about 7 P. M., and blew more from the north."

From the above accounts it appears that Midnapore, Burdwan, and Berhampore were nearly at the limits of the area of destruction, and that at these stations its force was not greater than that of an

* From Mr. James Perry, C. E., of the East Indian Railway. For this and other reports by the Engineers and servants of the Railway Company we are indebted to Mr. Power, the Chief Engineer.

ordinary stiff north-wester. In other words, that the area of destruction did not extend more than 35 or 40 miles to westward of the main central track, and the storm was not felt at all beyond about twice that distance. On the east, as we shall see, it was more extensive, and the destruction consequently somewhat greater. This appears to be due to the greater force of the south-westerly current, the recurvature of which, as we have seen, fed the storm on the east. Previous to entering on the description of the storm at the eastern stations in Bengal, it may be not uninteresting to note briefly the state of the weather in the Bay, and generally to the southward.

In Ceylon the stormy indications of the weather during the first days of October began to abate on the 4th, and on the 5th the Barometer rose about ·03 inches on the mean of the day. The wind, however, remained steadily between west and south-west, the lower clouds moving from west south-west. The weather damp and showery up to 2 P. M., after which it was fine; broken cumulo-strati passing, and squalls of wind.

At Port Blair the wind was from south-west, a moderate breeze, and weather fine.

At Madras the day was fine, and as at Ceylon, the Barometer, which had fallen ·042 on the 2nd, and ·035 more on the 3rd and 4th, began to rise. The wind, which had been northerly on the 2nd, 3rd, and 4th, and east by north on the evening of the 4th and up to 8 A. M. of the 5th, changed suddenly to south-west, and then worked round to its former quarter, but this was probably due to a local disturbance, as it remained northerly for a couple of weeks afterwards.

In the middle of the Bay, between latitude 17° and 19° north, the wind was south-west to south, and in the north-eastern part of the Bay south south-east to east south-east. [*See* Plate I.]

The log of the *Sydenham* is as follows :—"Wednesday, 5th.—Light variable winds from south-west to south, with a sea rolling down with great rapidity from north north-west. Ship pitching very much. I am under the impression that there is a Cyclone passing ahead of me somewhere to the north-west.—8 P. M. Barometer 29·80, and pumping a great deal. Heavy banks of clouds in the north-west and north-east, blackest in the north-west, with heavy flashes of pale blue lightning. Reduced sail and proceeded slowly up to north."

The *Nile*, 90 miles to north-west of the *Sydenham* (at noon), records as follows :—"October 5th. A. M. Wind west; head sea increasing.—Day-break; light winds hauling to south-west; a high northerly sea; ship plunging deep; obliged to take in studding sails.—Forenoon; Wind west south-west; weather cloudy at times; a heavy northerly sea; ship plunging deep throughout. A great many birds about the ship. Noon, moderate west south-west breeze, sea heavy from north; Barometer 29·96 (reduced 29·809); Thermometer 85° P. M.—moderate breeze with a confused sea on. Sunset—Wind south-west; head sea gone down; strong ripples; set all studding sails.—Midnight; light breeze south south-west.

The noon position of the *Clarence* was 85 miles north ½ east of that of the *Nile*, and she experienced somewhat similar weather.—"1 A. M., wind south-west; decreasing and weather clearing up with a high sea on.—5 A. M. High cross sea running from all directions.—6 A. M., daylight; Wind south south-west, fresh breeze and cloudy. Bore up north north-east, and made sail to double reefed topsails; whole foresail and fore-top-mast staysail.—11 A. M., wind south. Out second reef of main topsail and set main top-gallant sail.—Noon; fresh breeze and squally, with rain. Barometer 29·77 (reduced 29·628). Thermometer 82°.—1 P. M. Moderate breeze and squally with rain. Wind south.—3 P. M. Moderate and cloudy, with light rain at times.—4 P. M. Out second reefs of fore and mizen topsails; set top-gallant sails.—6 P. M. Light breeze and fine. The wind south from noon till midnight."

The *Golden Horn* having run up rapidly to the head of the Bay before a strong southerly wind, and then put about to the southward to get sea room, was at noon 96 miles north north-east of the *Clarence*. Her log is as follows :—

"Wednesday, 5th. A. M.—Squally, and heavy lightning with heavy appearance. Weather unsettled.—8 A. M. Wore ship to southward, continued heavy squalls with rain; split main topsail.—Noon; wind backing to south south-east.—P. M. Wind south south-east to south-east.—8 P. M. Split main topsail, unbent it and bent another. Wind moderate.—Midnight; set top-gallant sails over single-reefed topsails. Sounding every hour.

The *Conflict* was, at noon, 37 miles east south-east of the *Golden Horn*, her course for the day being to north-west and west north-west. "October 5th. A. M.—Heavy gale with awfully heavy squalls, accompanied by much

lightning and heavy rain, which lasted about half an hour. Stars out at times, shining bright: heavy sea running. Wind steady at south-east, but the squalls came from the south about every hour with great violence.—4 A. M. Barometer 29·63.*—6 A. M. More moderate. Bore away and steered north-west by north.—8 A. M. Barometer 29·68. —Forenoon; hard south south-west breeze with heavy squalls.—Noon, set upper topsails, foresail and jib. Barometer 29·70.—P. M. Hard south south-east breeze.—4 P. M. Barometer 29·70. Weather looks fine and more settled. Heavy swell on. At sunset this evening, the sky became awfully grand. [A light] appeared very suddenly in the east north-east. It broke out like a large patch of red clouds, and then opened all over the heavens, making water, ship, and every thing on board appear red. This came on so suddenly that everybody on board noticed it. Midnight; light south south-west breeze and fine. Barometer 29·70."

Lastly we give an abstract of the log of the *Proserpine*† Steamer, which at noon was 70 miles north north-east of the *Conflict*, and about 120 miles south-west of Chittagong. "Wednesday, October 5th.—1 P. M. Gale still increasing. Ship hove to; head to south-east. Immense heavy seas breaking over the forecastle and foredeck.— 4 A. M. Wind east south-east; Barometer 29·554;‡ Thermometer 72°.— 8 A. M. Wind east south-east; Barometer 29·514;‡ Thermometer 76°.— Noon. Wind east south-east; Barometer 29·503;‡ Thermometer 80°. During this forenoon the gale was at its height, the vessel plunging into the seas, and having over two feet of water on the upper deck. The lower part of the bulwarks were cut away to relieve the pressure forward, the boats cleared as much as possible and provided with water and provisions. Both anchors were let go, with 60 fathoms of chain each, and all heavy articles were thrown overboard. The vessel totally unmanageable, as she would not answer her helm. In the afternoon the weather appeared to brighten a little, and the Barometer steady. The ship rolling and labouring very severely. The sea not appearing to decrease in the least. At 4 P. M. the wind was from the south-east, Barometer still at 29·501, Thermometer 81°. 8 P. M., wind south-east by south, Barometer 29·539, Thermometer 74°. Midnight, wind south south-east, Barometer 29·590, Thermometer 70°. Weather clearing up a little, but still a fearful sea rolling.

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* These readings are all unreduced, no thermometric readings being given.

† Given *in extenso* in the Appendix.

‡ Readings reduced.

It appears from a comparison of these logs that the storm was far worse in the north-east corner of the Bay than elsewhere around the vortex. The heavy sea experienced by the *Proserpine* was doubtless in a great measure due to the shallowness of the water, but the gale was at the same time very severe throughout the day, notwithstanding that the ship was at an average distance of 200 miles from the centre. We have seen that on the west the storm was not felt beyond about 80 miles from the central track.

We now continue the record of the storm in Bengal.

Chittagong* is 250 miles to the east of the storm track. We have seen that a severe squall was experienced at this station on the afternoon of the 4th. On the 5th the weather was squally and unsettled. Wind strong, generally from the south-east, with showers of rain.

At sunrise	Aneroid	29·79,	Thermometer	76°.	Wind NE.
„ 10 A. M.	„	29·83	„	82°.	„ SE.
„ 1 P. M.	„	29·76	„	83°.	„ SSW.
„ Sunset	„	29·76	„	81°.	„ SSE.

At Burrisaul there was a squall with thunder and lightning between 9 and 10 of the evening of the 4th, with the wind from the east. A stormy wind blew all night from between east and north-east, but veered round to south about 9 A. M. of the 5th. At 10 A. M. a lull of four hours succeeded, and at 2 P. M. the wind recommenced and blew for nearly three hours. The damage caused by the storm appears to be but slight.†

From the lower Soonderbuns the only account we have of the Cyclone is from the Government River Steamer, the *Sir William Peel*,‡ which experienced it while at anchor in Channel Creek to the east of Sauger Island. The steamer was en route from Calcutta to Dacca and Assam

* This information is chiefly from Dr. Wise, the Civil Surgeon of the Station. Also partly from a note in the *Englishman* newspaper of October 20th, 1864.

† The above is abstracted from a somewhat metaphorical and amusing report by Baboo Chunder Banerjea addressed to Mr. Stewart, the Engineer of the Dacca Division. It speaks of the 'warring elements of Heaven,' 'the irresistible fury of the north-east wind,' which, however, appears to have done no damage whatever, 'the Cyclone (which was at no time within 100 miles of the station) pouring out the vials of its fury,' and concludes with the information that 'at the end the face of nature began to smile as ever!'

‡ Published in the *Englishman* Newspaper.

towing flats, with troops on board for the first Bhootan expedition. She entered Channel Creek about 3 P. M. of the 4th, and while steering down, a fresh breeze sprang up from the north-east with a heavy sea. She entered the Soonderbun River (the lower part of Channel Creek) late in the afternoon; and anchored a little before dark. The wind was fresh and steadily increasing. About 1 A. M. a violent gust passed over the Steamer, driving the passengers below; at the same time rain began to fall. Captain Wells at once ordered steam to be got up, and laid out fresh anchors. The wind continued steadily increasing. About daybreak a low humming sound was heard, as if very distant, increasing till the Cyclone burst with a roar, which continued through the whole of the forenoon. The river was lashed into waves of extraordinary size, which swept over the Steamer and poured into the cabins and cuddy. .... Towards 8 in the morning the steam was up and, with 65 fathoms of chain out, and steaming full power against the wind, the anchors were dragging. ... ... The Cyclone continued in full force until late in the afternoon, when the Steamer got under weigh and steamed further up into the creeks.

Jessore is situated about 50 miles to the east of the Cyclone track.* The morning of the 5th was raw and chilly, and was ushered in by stormy gusts of wind from the east, with a heavy continuous fall of rain. As the day advanced, the wind, still preserving an easterly direction, became higher and higher till it amounted to a perfect storm, which raged with great fury till about mid-day. It then began to moderate, and there was a lull which lasted about five hours. Between 4 and 5 P. M. the wind began to rise from the south-east, and the storm was renewed with the greatest violence, accompanied by torrents of rain. The hurricane attained its greatest violence between 7 and 10 o'clock at night, when the wind was south, and inflicted great damage on houses and trees. After 10 the wind began to diminish, and finally died away not long after midnight. The damage done in the station was considerable. A few trees were blown down; all from south to north.

It is interesting to note that the lull above mentioned is about synchronous with the breaking up of the Tumlook and Koila Ghat vortex and the formation of that of Santipur and Kishnagur. The same lull, but of shorter duration, was felt at Chowgatcha. [See *infra*.]

* From an account published in the *Englishman* Newspaper.

In the north-west corner of the Jessore district the gale was much more severe. We have received from Mr. Molony, the Magistrate of Jessore, accounts from the Deputy Magistrate of Chowgatcha, Jhindoh (or Jenada), Chandpore and Sindooree, all to the north and west of the station of Jessore. An account of the storm at the first-mentioned place also appeared in the *Englishman* Newspaper. From these we summarise the following:—

At Chowgatcha, 14 miles west north-west of Jessore and 34 miles from the mean central storm track, there was a stiff breeze from east by north, with squalls and rain. The sky was overcast, and there seemed every appearance that a gale was coming up. Towards mid-day the wind increased, with almost constant rain. About this time there was a lull, and the weather seemed to be clearing up, the wind being due east. About 1 P. M. it came on worse than before, and between 3 and 4 P. M. blew from east by south. The wind increased up to 9 P. M., and between 8 and 10 it blew with great violence from south south-east. By midnight the gale was over, wind from south-west, and next morning the weather was fine with the wind from west. A good many trees and native houses were blown down, and several natives were killed.

From Chandpore, 11 miles north of Chowgatcha and about 28 from the storm track, the account is much the same as the above, except that no lull is mentioned, and the storm is stated to have been very destructive between 7 and 10 P. M.

At Sindooree, 12 miles north by west of the last-mentioned place and not more than 20 from the storm track, the changes in the storm were similar, and it was at its height about half-past 9, with the wind from the south-east. The destruction was very great. Nearly every kutcha house was blown down, or much injured.

At Jenada, 27 miles north of Jessore, 13 miles east of Sindooree, and 33 miles from the mean central track, the force of the storm did not exceed that of a strong equinoctial gale, and to the eastward of this place it caused but little damage. To the westward it was much stronger, especially in the north-west corner of the district. It commenced about 5 or half-past 5 P. M., but had been blowing hard from the east, with slight rain, from 3 or 4 o'clock in the morning. In the evening it veered round to south-east, from which quarter it continued to blow till between 9 and 10 P. M.: it then moved round to the south and lulled about 11 P. M. It was strongest from the south-east between 7 and 9 P. M.

From Kooshtee Dr. Grant writes:*—"The storm began here with heavy rain and not an excessive amount of wind, from the north-east about the middle of the day. As the day advanced the rain gradually decreased, but the wind increased steadily, veering round still more to the eastward with fitful gusts, which blew the rain into a mist. By 9 P. M. the wind was about due east, and we were becoming conscious that something more than an ordinary gale was blowing. From this time to about 11 P. M., I think, the storm was at its height.....With very few exceptions every hut and tree was blown down; gardens destroyed, &c. The wind, while doing all this mischief, gradually veered round from east to south, and blew hardest, to my impression, from about the south-east; for when it got fairly to the south its force was reduced, and by the time it had a little westing in it the storm had begun to abate, which was about midnight, having lasted about twelve hours altogether. There were three fires, (small villages I fancy,) which cast a red glare over the scudding clouds. Though the natives declare they saw all sorts of lights, I can't say I saw anything more. Possibly, however, electrical phenomena were observed, though I may not have seen them.†"

The following is abstracted from an account of the storm, as experienced at an Indigo Factory 12 miles south-east of Kooshtee, which appeared in the *Englishman* Newspaper of October 14th:—

"On Wednesday, 5th, we had heavy rain throughout the day, strong wind about east by north, with heavy gusts at intervals, increasing in violence towards evening. About 7 P. M. the wind was almost due east, the gale increasing. At about half-past 9 to 10 P. M. the wind almost due south. At about 11 P. M. blowing from south-west, and gale moderating. It blew hard till past midnight, but was severest between half-past 8 and half-past 10 P. M. Large trees were uprooted, lying north and south, kutcha houses blown down, and boats sunk..... .....The natives speak of having seen luminous appearances in the heavens, reddish in color, coming from different quarters, meeting and falling like a stream of fire. At about 10 P. M. the western horizon had a lurid appearance."

* With this was received a diagram showing the wind changes, from which the tabular account had been compiled.

† Compare the account next following, and those from Nattore, Boraignon, Dadupore, Juraalpore, and especially Captain Graham's account of the luminous appearance observed by him from his boat on the Jhenni River.

It may be noticed that in the two last accounts, the height of the storm is stated to be between 9 and 11 P M., (mean 10 P. M.,) and half-past 8 and half past 10 (mean half-past 9), which tally well, the former station being some miles to north of the latter. But both stations are considerably in advance of Mehurpore, where the centre passed a few minutes after 10. Moreover, it may be noted, that the wind was veering rapidly to the southward at the time of the maximum, as if the centre were then passing, whereas in point of fact it was about 20 miles (more than 2 hours' average progress) in the rear. We shall see that in the same way a veering to the southward, at an earlier hour than we should have anticipated from the ascertained progress of the centre, is noticed at Pubna and Dadupore immediately north of Kooshtee, and at more easterly stations, Furreedpore, Dacca, &c., and that the passage of the centre over Nattore probably took place simultaneously with its passage at Mehurpore, or according to some accounts, which for reasons which we shall give in the sequel, we cannot accept as trustworthy, as a time which could indicate a rate of progress of 25 miles an hour; while at Nattore there was a lull of about an hour, indicating a slow rate of progress. All these facts, which we shall now detail, seem to indicate (notwithstanding some anomalies, probably due to inefficient observation,) that as between Koila Ghat and Santipore, so between Mehurpore and Nattore, a new focus was started, the previous one dying out and disappearing. We may also draw attention to the luminous appearances said to have been noticed by the natives at the two last-mentioned places. A fuller and less questionable account of them is given in subsequent accounts.

Furreedpore* is situated on the Pudda (Ganges) 40 miles east south-east from Kooshtee. The storm was but moderate at this station, and did no damage. On the evening of the 4th there was a series of slight squalls from the south and south-east. The morning of the 5th was fine, but about 8 or 9 A. M. the squalls recommenced from the north and north-east. It scarcely ceased raining between 4 and 5 P. M., and from 10 A. M. to 5 P. M. there was a fresh wind, but not severe enough to do any damage, or even cause any inconvenience. At 3 P. M. the wind had gone round by east to south-east, and continued in that quarter or thereabouts for several hours. From 6 P. M. the wind gradually increased in strength till about 10 P. M., gradually going round by south

* This account was received from Mr. Patton through Mr. Stewart, the Executive Engineer of Dacca.

to south-west. From 10 A. M., and after reaching south-west, it gradually went down. There was rain with the wind throughout. No damage was done beyond a few huts and small trees being blown down. The following are the wind and thermometer observations for the day :—

	Thermometer.	Wind.
6 A. M.	77°	N. E.
10 A. M.	78°	N. E.
4 P. M.	78°	S. E.
10 P. M.	78°	S. W.

The rainfall was 2·4 inches.

From Dacca, 105 miles from the storm axis, we have accounts by Mr. Buckland, Mr. Stewart, and Mr. Smart. The former writes :—

"A very strong easterly wind set in about 8 A. M on the morning of the 5th, and blew during the whole day with heavy rain. At night the wind came round more to the south-east and south, and fell away about 6 A. M. on the 6th. The force of the wind did not amount to that which I have observed in three real Cyclones, and it seemed more like a furious rush of air towards a Cyclone, than the violent and irresistible blasts of a Cyclone."

Mr. Stewart mentions that the weather was cloudy all day, with rain in the evening. The storm began about 8 P. M., and was over by 2 A. M. of the following morning, the wind being from south-west to south; no damage was done in the town, but a few boats were sunk in the large rivers.

Mr. Smart's account is more detailed. "The 4th October was very sultry and hot. There was not a breath of air throughout the day. In the evening there was lightning to the north-east and south-east, and at 9 P. M. a light shower of rain. The morning of the 5th was dismal and gloomy; the wind from the east, and increasing with variable squalls. To the south-east, south and south-west the sky assumed a grey and heavy appearance, and this weather continued throughout the day. About 5 P. M. the wind changed to south-east, and increased to a decided gale. At 11 P. M. the wind was at its height, and thunder was distinctly heard, accompanied by a heavy driving rain. At 1h. 30m. A. M. of the 6th, the wind was veering gradually to south-west, and then began to abate."

Even so far east as Comillah* a strong wind was felt, accompanied by rain, throughout the day and night of the 5th. The wind was from south-east at sunrise, but soon after changed to south, from which quarter it blew in gusts for the remainder of the day. The rainfall was 2·5 inches.

We now proceed to recount the passage of the storm as reported from the stations north of the Ganges, beginning with Rampore Beauleah to the west of the track, proceeding with those which lay on the central track, Nattore, Shingrah, Sherpore, and Bograh, and concluding with those to the eastward.

From Rampore Beauleah, Mr. Blechynden communicated the following account to the *Englishman* Newspaper:—

"October 5th.—7 A. M. cloudy, with wind from north-east;—10 A. M. cloudy and drizzling; wind from north-east;—1 A. M. clouds flying low, showers off and on; wind north-east and blowing stronger;—2 P. M. blowing stronger; not so much rain; wind still north-east, and indications of bad weather, Thermometer 84°; Barometer 29·40;—4 P. M. wind on the increase, still north-east; a gloomy look; Thermometer 84°; Barometer 29·38;—6 P. M. blowing strong and in gusts; more rain; wind north-east; Thermometer 80°; Barometer 29·33;—8 P. M. wind very much increased and the gusts stronger; Thermometer 80°; Barometer 29·30; direction of wind north-east by north;—9 P. M. blowing a strongish gale; gusts at times very severe; Thermometer 78°; Barometer 29·27; wind veering to north north-east;—10 P. M. blowing a perfect gale; wind in severe gusts accompanied by a sound like distant thunder; wind north; trees beginning to fall; Thermometer 75°; Barometer 29·20;—11 P. M. a very severe gale, blowing steadily, with, at times, very severe gusts; wind north; Thermometer 72°; Barometer 29·15.

"October 6th.—12 midnight, gale at its highest, no walking against the wind, which had veered to north-east by north, northerly. Trees falling and branches being knocked off; raining hard, Thermometer 72°, Barometer 29·00;—1 A. M. the same as above, wind north;—2 A. M. wind due north-west, the gusts less frequent, but the steady blow very strong. Thermometer 72°, Barometer 29·00;—3 A. M. still blowing hard, but not so

* From a Meteorological Report by Dr. Greene, the Medical Officer of the station.

severe; rain freer; Thermometer 72°, Barometer 29·3; from which time the gale abated, and at 10 A. M. there was sunshine, and wind south-west."

A report from the Executive Engineer of Rajshaye differs somewhat from the above.

"Several days previously to the 5th October, heavy clouds were gathering round the station: on the 3rd and 4th the upper strata passing with great velocity northward. On the morning of the 5th the atmosphere was misty, and by 10 o'clock rain began to fall, and continued throughout the day, not very heavily, but driven by a strong north wind, the first which had blown from that quarter during the previous nine months. At 7 P. M. the wind veered to north-east, and increased in violence; by 10h. 30m. P. M. it was from the north, and blowing very strongly. It continued thus till 2 A. M. (on the 6th,) when the wind shifted to north-west, and the violence somewhat diminished, and by 6h. 30m. A. M. it was coming from due west, and with a few irregular puffs the storm subsided." A number of trees and native huts were blown down, and in the town of Rampore one pucka house and 200 cutcha houses were destroyed, and one man killed. From this it would seem to have been more severe at Rampore Beauleah than at Berhampore, which is about at the same distance from the central track.

From Nattore we have two brief accounts, which do not indeed agree with each other as regards the wind directions, nor the times of the changes in the storm; nor are they consistent on this latter head with the accounts from Shingrali, Boraigaon, and other places in the neighbourhood, as may be seen by reference to the Table p. 29, and the map Plate II; but after making due allowance for errors, there remains but little doubt that the centre passed over Nattore, and at a much earlier hour than could be accounted for on the supposition of the vortex being the same as that which passed over Mehurpore, from which place Nattore is 51 miles distant (by compass).

The following is the Police report:—"The Cyclone commenced about 7 o'clock on the evening of the 5th October, and lasted till 3 o'clock in the morning. The wind blew from the north-east [till] about midnight, [when] there was a lull, and then the wind shifted to the north-west, blowing as hard as ever..... During the storm a brilliant meteor was seen."

A report of the Executive Engineer, (not drawn up from personal experience,) states that the lull in the storm was from 10 to 11 P. M., and occurred after a sudden change of the wind to south-west, the wind having been blowing from the south from 7 P. M. After the lull the wind again blew from south. We have, however, little doubt that the compass points are erroneously reported.

Boraigaon is 12 miles south-east by east from Nattore. The following is the Police report from this place, drawn up, it should be remarked, by the same Officer, Mr. Gouldsbury, who furnishes the reports from Nattore (above given) and Shingrah :—

"At 8 o'clock P. M. on the 5th October the Cyclone commenced, and lasted till morning, the direction of the wind north-east, and after midnight north-west ..... During the storm a bright meteor was seen."

From Shingrah, 9 miles north-east of Nattore, the Police report is as follows :—

"The height of the storm was between 3 o'clock and 12. Wind north-east. After a lull of an hour it came on from the west and lasted until 4 o'clock, the force of the wind gradually abating."

A more trustworthy account than these last is that which Mr. F. Grant gives of his experience in a boat on the river, 15 miles north-east of Nattore :—

"The whole of the 5th was squally. The wind gradually increased, and from about 9 to 11 P. M. it blew a perfect hurricane. The direction of the wind, as far as I could make out, was north-east. About 11 o'clock there was a perfect lull, after which it again commenced to blow with greater violence than ever. This time the direction of the wind was north-west. Between 1 and 2 A. M. of the 6th, the gale began to subside, and by the morning it had ceased."

A correspondent of the *Englishman* gives the following details of the storm at Sherpore, 12 miles south of Bograh :—

"The morning of the 5th broke with light rain falling and a pretty strong breeze from the eastward, with occasional slight squalls. The weather continued thus till mid-day, the easterly wind rising slightly. In the afternoon, however, it rose gradually, till at sunset it was blowing a strong gale with heavy rain and squalls; but there was no indication of what we were about to get, and I was in hopes, at one time, that

the gale had broken; but I soon found out my mistake, for the wind, after a lull of about half an hour, again rose and went on rising, and at midnight it was blowing a fearful gale from the east, with very heavy squalls and rain. After 1 o'clock the wind began to shift round to the south, and by 2 it was blowing heavier than ever from that quarter, and continued so for about two hours, when it again shifted to the west, but did not remain long there, being after sunrise about north-west. It then went on round to the north and steadied and fell by degrees, and by mid-day it was again calm. The wind was at its highest between 1 and 3 o'clock of the morning of the 6th, that is, during the period of its changing from east to west."

From Bograh Dr. Tayler gives the following excellent account, for which, with many others, we are indebted to Dr. Partridge :—

"I find from my register on the 4th, the weather was cloudy and close; wind north in the morning and north-east at noon, and in the evening and at night; with a little rain, not sufficient to register. On the 5th, rain; wind still from north-east, increasing from noon until it became a gale at 9 P. M., and continued to blow with increasing violence up to midnight, when there was a sudden lull about a quarter past 12 for about 20 minutes, and the wind veered round by south to south-west, and from this point blew as fiercely nearly as before for about two hours; gradually changing to the west and subsiding about 4 A. M. of the 6th. I was up nearly the whole of the night of the 5th, and from my own observations and those of others in the station I feel certain that the wind veered round by the south to south-west. I was here in the Cyclones of 1842 and 1852. The former was not very much felt in Bograh. The latter was certainly very severe, and the gale continued much longer than this late one, but the wind in this blew with much greater violence. The fall of rain from the morning of the 5th to the subsiding of the gale at about 4 A. M. of the 6th, was 7·1 inches."

The Executive Engineer of Rajshaye writes as follows:— "The morning of the 5th was ushered in by a very hot sunrise, but shortly after, the sky was overspread with dark lead-colored clouds, and there arose a breeze from the east, which came up in puffs. At 1 P. M. slight rain came on, and the breeze began steadily to increase till sundown, when the wind veered a little to the south; and the force of the wind increased very much. It was accompanied by rain. At 2 A. M. of the 6th the gale was at its highest pitch, and the violence of the wind was something terrific."

Amid all the discrepancies in the above accounts it is extremely difficult to ascertain the probable course and rate of progress of the storm. The Police reports and those of the Executive Engineer cannot be accepted as very trustworthy, as they are not given from personal experience, and, except as affording evidence of the occurrence of a lull in the storm at Nattore and Shingrah at some time in the middle of the night of the 5th, they must be set aside as of little value in a case of discrepancy. There remain the report from Sherpore, that of Mr. Grant from a place 15 miles north-east of Nattore, and Dr. Tayler's account from Bograh; but even from these it would be extremely hazardous to draw any decided inference, as we do not know how far the hours given are based on actual observation rather than estimate. The two latter accounts indeed tally pretty well, as the lull indicating the passage of the centre was experienced by Mr. Grant at 11, and by Dr. Tayler at quarter past 12, but at Sherpore, which is situated between the two positions, the changes in the wind indicating the passage of the centre did not commence till 1 A. M., between which and 3 A. M. the gale is stated to be at its maximum. On the whole, it would appear most probable that the storm centre passed Nattore, as recorded by the Executive Engineer of Rajshaye, about 10, Mr. Grant's position about 11, and Bograh about quarter to half-past 12, but we must confess that this inference is but a probability, and cannot be accepted with any great confidence. It is pretty clear that the course of the centre was over Nattore and Shingrah, and immediately to the west of Bograh, the eastern limb of the calm just passing that station. It is quite possible that there may have been more than one vortex.

Of places north of the Ganges and to the eastward of the storm track we have accounts from Dadupore and Pubna immediately north of Kooshtee, also from the Jhenai River, Jumalpore, and Mymensing, all to the east of Bograh.

From Pubna Mr. J. Parker writes;—

"During the whole of Wednesday, the 5th, we had rain accompanied by strong wind from the east, which continued (lulling at times for a few minutes) till 6 in the evening, when the wind increased. At 7 A. M. it was blowing a perfect gale from the south-east, and continued to increase in violence till between 10 and 11, when it was at the highest; so much so, that a portion of the pucka work of my house fell, and the whole of the kutcha out-houses and trees were levelled to the ground.

After 11 P. M. the wind gradually fell, and at midnight the gale was considerably over: however it blew fresh till the morning. I did not notice a lull of more than a few minutes, and to my knowledge there occurred no decided lull of any duration. My family said they felt the shock of an earthquake at 25 minutes past 10 P. M., and were much alarmed."

The occurrence of the earthquake is doubtful. Something of the kind is recorded at one or two stations, but there is no evidence that can be regarded as satisfactory.

At Dadupore* there was a little rain at 11 P. M. on the night of the 4th. The morning of the 5th was ushered in with rain, and wind blowing in puffs from the east, and it continued to rain and blow the whole of the day. At 7 P. M. the wind veered to the south, and increased gradually in force until 10 P. M., when the gale was at its highest pitch, and it continued to blow till 2 A. M. of the 6th, when it began to abate. It was quite over by 6 A. M.

"During the night of the gale numerous fires were raging in all directions, and in looking out upon the storm the night was something beautiful to behold, a black mass, as it were, rushing past, with the sky above it perfectly red as after a rosy sunset. The natives believe that the redness of the sky was caused by a meteor and not by the fires that were raging at the time." There is little doubt that the natives were right in this matter, as will be seen from the following account.

Captain Graham's account† of the storm, as experienced by him in a boat on Jhenai River, is of especial interest from his graphic description of the light which accompanied the storm, and which, as we have seen, was noticed in a more or less casual manner, both at Calcutta and at several stations to the northward. It is the more interesting when it is remembered that, except on the outskirts of the storm, as at Dacca, Chittagong, &c., none of the usual electrical phenomena were observed, an absence which has been specially noticed as peculiar by several who have experienced other Cyclones.

"On the 5th October the wind had been blowing all day in stiffish squalls, accompanied by rain, and its general direction was about east to south-east. At about 4 P. M. the wind went to north-east, and my manjees (boatmen) saying they could not make way against it, I

* This account is from the Executive Engineer of Rajshaye.

† For this interesting letter we are indebted to Dr. Partridge.

anchored near the east bank of a low mud island in the River Jhenai, at a place called Shahgunj, latitude 24° 50′; longitude 89° 48′. Between 8 A. M. and 9 P. M. the wind increased very much, blowing from north-east; and finding the boat dragging, I let go a second anchor. There was then a slight lull, but a little after 10, on it came again, driving the boat on shore, and fixing her stern post and rudder fast in the mud, where, the boat being unable to rise to the waves, they washed in over all and swamped her. We then jumped on shore, and sat cowering on the mud under an old sail. Shortly after we landed, (say at about 11 P. M.,) there was a decided lull, and after this it came on again, veering to the north, at which point I first observed a pale, bright light, on almost a level with the horizon. This light, I observed, accompanied the wind round to the north-west, where it stopped, and again began to move to the north-east. Thence it went round with the wind to the east and south-east, being sometimes high and sometimes low in the heavens, and finally, at about 1 o'clock on the morning of the 6th, it broke out in great splendour in the south-west, lighting up the whole sky, and appearing like the sun breaking through murky clouds at mid-day. The country was partly lit up, and I thought the day had broken, but after about half an hour the light disappeared, and left every thing as dark as ever. At about 3 A. M. the wind decreased, but still blew strongly up to 8 A. M., from which time it gradually died away to a calm—at all events to a gentle breeze from the south-west. My watch having been under water stopped shortly after 10 P. M., and the hours given above are therefore only approximative, but the directions are pretty near the mark, as I knew the directions of the river beforehand, and calculated by that at the time and with a view to future use. ..... So far as I can recollect, for about 24 hours before the gale, the wind was about south-east."

Our next accounts are from Jumalpore, about 15 miles from Captain Graham's position. Here also luminous appearances were noticed, though (as reported by the natives,) of a different character to that above described. We have four letters describing the storm, all, however, from the same writer, Mr. W. Tayler. From these we extract the following:—

"The day of the 5th was stormy looking. The wind gradually freshened to the evening, and about 9 P. M. it was blowing a stiff gale from the north-east, with rain. The wind then increased in strength, veering

round to nearly due south at about 1 or 2 A. M. of the 6th. From this quarter, or from a little east of south, it blew with great fury, sinking a great number of boats, upsetting large trees, and blowing down about 25 per cent. of the native huts. After 2 A. M. it gradually slackened, up to 8 A. M. of the 6th, veering round to the west. It then lulled, but at 9 A. M. came from the north-west and gradually increased in strength for a short time, after which it died away entirely. The strength of the storm lasted for two or three hours, the strongest wind being from south by east. During the height of the storm, curious lights were seen of two sorts, *viz.*, balls of fire, two or three or more together, floating about and settling on the trees; and distant glares like villages burning, or day-break. The rain was not heavy, but fell throughout the storm."

Mymensing is 31 miles east of Jumalpore and 65 from Bograh. The storm was felt here, but with no great violence. The following is an account by Dr. J. G. French, for which we are indebted to Dr. Partridge:—

"5th October.—The day and morning up to about noon was hot and sultry. The sky was clear and cloudless. About noon the weather changed, the sky became cloudy, and a drizzling rain fell. About 5 P. M. the wind increased slightly, but still was nothing more than a breeze. The rain began to fall more heavily from that hour, and the breeze began to increase slightly in force, but gradually. From 7 o'clock to 10 the breeze was blowing more strongly, and rain fell in torrents..... This continued up to about 12 A. M., when it blew a regular storm. About 3 A. M. it began to abate gradually, and ceased altogether about 9 A. M. No trees were torn up, no branches were stripped, and no boats were destroyed. No houses in the bazar were thrown down. The wind came first from the east, up to 12 (midnight). When the storm was at its height, at 1 A. M. of the 6th, it blew from the south-east, then gradually came from the south, and at its termination from the south-west. It seemed to go on to north-west, north and north-east."

Beyond Bograh the course of the storm appears to have been a little to the west of and parallel to the line of the great river, when it gradually expended itself along the western escarpment of the Garrow Hills. We have, however, no detailed data from between Jumalpore and Gowalpara in Assam, if indeed it be the same storm which was felt at the latter place on the 7th October. We have, however, accounts from Rungpore and Dinagepore, the former 33 miles to the west of the Brahmoputra and

63 miles north of Bograh; the latter 73 miles west of the river, and nearly on a parallel with Rungpore. The following is from a letter by Mr. Wavell, of the B. C. S., stationed at Rungpore:—

"On Wednesday, 5th, there had been drizzling rain at intervals all day long, with an easterly wind, which increased steadily after sunset till about 9 P. M., when it blew a tolerable gale, still from the east. At about 1 or 2 P. M. there was a strong gale from the north-east, which continued for about a couple of hours. The wind was at its height at about 4 A. M., when it was blowing from due north, as shown by the fall of trees about the station. It gradually veered round, still blowing with great strength, till it died away to the south-west about 8 A. M. A great deal of rain fell during the night."

The following information, from the same letter, seems to indicate the course of the storm to the north of Bograh:—

"At Bugwah on the Brahmoputra, (nearly due east of Rungpore,) the wind is reported to have been very strong, and I have heard from Colonel Haughton that some Cooch Behar boats went down in that river. At Bhowanigunj, a sub-division about 6 miles from the Brahmoputra, [in the direction of Jumalpore], the storm does not appear to have been felt very severely. It was stronger at Sadoolpoor, a thannah about 12 miles north-west of Bhowanigunj. At Peergunj, a thannah on the road to Bograh, and at Bagdwar a few miles to the east of that place, the wind did a great deal of damage to houses and trees: in fact the storm would appear to have been more severe than in any other part of the district. I do not think the storm went far north of Rungpore. At any rate its force was much diminished. At Kishoregunj, a factory 19 miles west north-west, and at Dinagepore, it was only a strong wind. At Julpigoree it was not at all severe."

The above is sufficient to indicate pretty clearly that, after passing immediately to the west of Bograh, the mean track of the storm continued north north-east and struck the river about Bugwah at about 4 A. M. on the morning of the 6th. It is clear from Mr. Wavell's account, that the storm diminished rapidly in extent and force during this short transit, owing, no doubt, mainly, to the impediment offered by the Garrow Hills, to the strong current which chiefly fed the storm. From Bugwah to Gowalpara its course was exceedingly slow, and by the time it reached that place it was nearly exhausted.

At Dinagépore "a sharp breeze sprang up from the east between 5 and 6 P. M. on the evening of the 5th October, and the wind steadily blew from the same quarter, increasing in violence and gradually inclining southwards till 1 A. M. There was then a lull for about an hour or till 2 A. M., and then the gale again commenced from south-south-west and west. It blew on till day-light of the 6th."

From Cooch Behar, 41 miles north by east from Rungpore, Colonel Haughton writes:—

"Monday, 3rd October, very fine weather. Tuesday, 4th, day-light; sky overcast, and as the day advanced, that peculiar dark leaden appearance which enables one so surely to prognosticate heavy weather. I felt sure we should have another bout which would close the rains. Direction of the wind not noted. Wednesday, 5th; rain commenced last night, or rather this morning, at 2-30 A. M. Continued constant, but not heavy throughout the day. Thursday, 6th; rain has continued to fall last night and continues this morning. Gale of wind blowing during the night from north-east with heavy squalls, roofs all more or less injured. This afternoon the wind lulled and the rain ceased for a while, but came on again towards sunset. Friday, 7th; it rained all last night, but cleared up in the morning. Saturday, 8th; fine. My impression is that on Wednesday the wind veered from east south-east to east and north-east. The severest squalls were, I think, about 2 A. M. on Thursday."

Finally, from Gowalpara in Assam, we have an account from Dr. F. V. Walker. "5th October; rain cleared off; light variable wind; warm sultry weather. Night excessively hot; wind calm. Morning of the 6th cloudy; heavy rain; clouds rolling up from south-east by 10 A. M., which gradually increased till evening. Thermometer at sunrise 78°; at 5 P. M. 68°, having fallen 10°. Wind at 10 P. M. light-south. At midnight strong breeze from south-east, which continued to increase till 2 A. M. of the 7th, when a strong gale set in: velocity of wind irregular, blowing with great force for some minutes, then gradually abating, only to recommence with greater violence. Direction of wind south-south-east to east: rain coming down in torrents the whole time. At 6 A. M. of the 7th, the rain gauge held* 30 inches [query, 3 inches?] *i. e.*,

* This rainfall, if accurately given, far exceeds that of Cherra Punji at the height of the rains. We cannot but think that these registers should have the decimal point altered one figure, *i. e.*, be divided by 10. Even with this alteration the rainfall would be very heavy.

5 inches per hour since midnight. Wind south-east; blowing a steady gale, which continued till noon. Thermometer 67°. Rain fell from 6 to 8 A. M., 3·5 inches [?]; from 8 to 9 A. M., 4·75 [?]; Thermometer 68°. From 9 to noon, rain 13·5 inches [?]. At noon a perfect lull, lasting about ten minutes. The wind then came up from north-east, shifting round to north and back to north-east for an hour. At 1 o'clock another shorter lull of a few seconds occurred; wind shifting to south and south-east, and continued very heavy from that quarter till about 5 P. M.; Thermometer 66°; rain fall 8 inches. From this period till 6h. 30m. P. M. both wind and rain gradually abated, and ceased about 7 o'clock. Although we had a very severe storm, the amount of damage was inconsiderable. Some trees were blown down, but the greater number of the large trees suffered the loss of their exposed arms only. It was more of a deluge than a hurricane, 5 feet [?] of water having fallen, and this quantity is considerably under the truth, for my pluviometer was blown out of its cradle several times, and hence a large amount of water got capsized."

We should infer from the above, that the storm still preserved a cyclonic character, passing from west to east, but that when passing Gowalpara it had nearly exhausted its strength, and it probably died away at no great distance up the Assam valley.

We have thus traced in detail the progress of the Cyclone from its commencement to the north-west of the Andamans on October 2nd, to its approaching termination in Lower Assam on the afternoon of the 7th. To complete this record for the 5th and 6th October, it only remains to notice briefly the state of the wind and weather at some stations at a distance from the storm. We shall then summarise the meteorological features of the Cyclone, as deduced from the data thus placed on record.

At Sahibgunj, on the East Indian Railway, to the west of the Rajmehal Hills, "the wind was westerly till about 10 A. M. on the 5th. It then chopped suddenly round to east, and blew a little fresh and very cold for the time of year. From 10 A. M. to noon the wind went round to all points about 12, it then blew steadily from the east; cold and very dark. The wind was strongest about half-past 11 A. M."*

* From R. Ewing, Esq., of the East Indian Railway.

"At Bhagulpore,* the 5th was cloudy throughout, with a strong fresh breeze from the south-east without any perceptible change in force up to 5. P. M. The breeze was nothing approaching to a gale or storm. At 4 P. M. dark heavy clouds arose in the south-east, which forebode a coming storm. At 5 P. M. the breeze got a little stronger, and a few heavy and large drops of rain fell, after which the dark clouds dispersed and passed over."

At Benares, the Barometer fell slightly but steadily from the 1st to the 6th, the difference of the mean readings for these two days being 0·05. It rose again on the 7th and 8th. The wind on the 5th was from south-east in the morning and north-west in the afternoon, and blew from north-west and south-west for the three following days.

At Darjeeling the wind was south-westerly on the 1st and 2nd, from the east on the 3rd and 4th, and from the north-east with rain on the 5th and 6th. The temperature fell two or three degrees with the north-easterly wind.

At Cachar the wind was variable on the 5th and 6th.

SUMMARY OF METEOROLOGICAL PHENOMENA.

It remains now to discuss the data contained in the foregoing pages, and to draw such general conclusions as may be of service either to the practical or theoretical meteorologist. In so doing, we shall not confine ourselves strictly to the phenomena of the present storm, but by instituting a comparison between them and those of Cyclones previously recorded, chiefly in the works of the late Mr. Piddington, we shall endeavour to distinguish between those features which are common to all Cyclones of the Bay of Bengal and those which are special and in a measure peculiar to that of 1864. The subject may be conveniently treated under the following heads and in the order of their enumeration :—

A.—Barometrical phenomena.
B.—Hygrometry and rain-fall.
C.—Anemometry. Direction and force of wind currents.
D.—Electrical phenomena,

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* From J. Dawson, Esq., C. E., District Engineer of the East Indian Railway.

and we shall conclude this part of our subject with a short discussion on the laws of cyclonic vortices of the Bay of Bengal, so far as they have been ascertained, or are suggested by our present researches.

A.—Barometrical Phenomena.

It is universally admitted by meteorologists that the variations in the pressure of the atmosphere are the cause which determines wind currents, the air always flowing from places of comparatively high to those of comparatively low barometer.* The diminished pressure of the atmosphere over any given spot is assigned partly to the expansion of the air over that spot by the heat of the sun, and its consequent ascent and overflow in the upper regions of the atmosphere, partly to the condensation of water vapour in the atmosphere, and the consequent heating of the latter by the evolution of the latent heat of the vapour. In both cases, an upward current is established, the barometric pressure is diminished, and, as a secondary effect, air currents are set in motion towards the place of low barometer. It is, therefore, in the indications of the Barometer that we must seek for the primary causes of cyclonic winds, which being at first rectilinear, converging or opposing currents, *i. e.*, currents from opposite quarters, become eventually vortical, in accordance with the well known law first enunciated by Dove.†

Reasoning on these *à priori* grounds, we should expect to find that a low barometric pressure prevailed for some time previous to the formation of a Cyclone over the area in which the cyclonic movement subsequently originates, an area which in the Bay of Bengal is shown by Mr. Piddington's Storm Charts to be not unfrequently in the neighbourhood of the Andamans, and nearly in the middle of the Bay. We have shown that the Calcutta Cyclone of the 5th October 1864 originated in

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* This is not to be taken as true in detail, although true on a great scale. Thus, in every eddy the wind circulates more or less *around* the place of low barometer, and in violent Cyclones, moves nearly in a tangent to the place of lowest atmospheric pressure. Moreover, as Professor Dove has shown, currents from a distance, whether from north or south, pursue a curvilinear path in virtue of the diminishing or increasing velocity of rotation of that part of the earth's surface towards which they tend. Neither is it to be inferred that a rising or falling barometer always *determines* wind currents from to or to the place of observation. They frequently *betoken* and are the effects of mere changes of wind.

† 'Klimatologische Beiträge,' pp. 184, seq. Also, 'Gesetz der Stürme,' 2te. Aufl. pp. 1 seq. and p. 129. See also 'Bericht der Berliner Akademie, 1840 p. 232,' and 'Poggendorf's Annalen, 52, p 1.'

this region, and we have endeavoured, by a comparison of the few barometric observations obtainable, to ascertain how far the observed conditions corresponded with those indicated by theory. In this attempt we have been but partially successful. The Kandy, Madras, and Calcutta observations alone have been taken with such precautions as to admit of strict comparison, and the Port Blair observations, which are the only series we possess from any point near the Cyclone-cradle, are only admissible on the supposition that they do not very greatly depart from the truth, *i. e.*, that the Barometer of the *Tubal Cain* is a fair average instrument, and that the readings have been made with such care as is usual on board the better class of vessels.

This much may, however, be predicated. That the Barometer at Port Blair was very low on the 27th and 28th September* (possibly also for some days previously, but we have no data for previous days), and that at the same time the barometric pressure at Calcutta was unusually high. We have no sufficient data from Madras and Kandy to allow of any comparison of their barometric readings with the averages of past years, but they were as much or nearly as much higher than those of Port Blair on the days specified, as were the Calcutta readings.

Thus, then, our data indicate the existence of the state of things that might be expected on *á priori* grounds to precede and produce converging currents and a consequent Cyclone. With the formation of a vortex and consequent ascending current, the Barometer would probably fall still lower in the Cyclone and its immediate neighbourhood, but the ship observations are scarcely sufficient to indicate the amount and rate of this fall, as they are not susceptible of comparison, and excepting the *Clarence*, which was certainly very near the centre on the 4th October, we cannot ascertain with any certainty how far the ships were at any given time from the centre of the vortex. From half past 3 to 4 P. M. on the 4th October, the Barometer of the *Clarence* stood at 29·35, which, reduced by the noon temperature, (and in such storms the Thermometer varies but little,) would be 29·21. At this time she must have been within 10 miles of the central calm, possibly less, and we should therefore infer that the minimum barometric pressure of the storm was higher than when on the following day the storm passed over Lower Bengal.

* The observations, it may be remarked, are those of noon, and therefore, as the hour of maximum is 9 h. 30 m. or 10 h. A. M., and the minimum 4 P. M., somewhat higher than would be the average for the day.

Previously, on the night of the 2nd, the *Conflict* and *Golden Horn* crossed the path of the advancing Cyclone, and when, had the vortex advanced regularly, it must have been about their position. Yet the Barometer of the former ship did not indicate a lower pressure than 29·76 (unreduced), but it fell afterwards to 29·60 (unreduced), as the ship advanced northward nearly parallel to the Cyclone path.

On the other hand, on the *Chinsurah* and *Foam*, both of which must have passed very near and to the west of the centre at midnight of the 4th, (how near we cannot ascertain,) the Barometer fell to 28·72* and 28·40* respectively. The latter reading is, however, probably too low, as a comparison of the readings of the two Barometers when at the Sand-heads shows that that of the *Foam* is 0·28 below that of the *Chinsurah*. Making this correction, the minimum reading of the *Foam* would be 28·68, which tallies closely with that of the other ship.

When the centre of the storm passed over Contai, at half past 10 on the morning of the 5th, the Barometer, (an Aneroid,) stood at 28·025, or, as corrected by subsequent comparison with the Calcutta Standard (for the daily range), 28·083.

It thus seems probable, though not satisfactorily proved, that the barometric pressure at the storm centre diminished during the passage of the latter up the Bay, but if so, it must have reached its minimum in or about the lower part of Bengal. The lowest reading taken by Mr. Savi at Moisgunge at 6 h. 30 m. P. M., during the few minutes' lull which at that place indicated the passage of the central calm, was 28·36, which, if reduced for temperature, would be 28·23 approximately.

The depression of the Barometer during the passage of the storm, was felt as far west as Cuttack, 150 miles from the central storm track, as is shown by the following series of observations; but no storm was experienced:—

October.	Sunrise.	10 A. M.	4 P. M.	10 P. M.
3rd	29·70	29·74	29·65	29·68
4th	29·65	29·68	29·59	29·56
5th	29·50	29·58	29·55	29·65
6th	29·65	29·72	29·68	29·74
7th	29·73	29·77	29·68	29·74

* Unreduced. The reduced readings are given at pp. 24-25.

This Barometer (an Aneroid) appears to read low, so that the readings are only comparable *inter se.*

To the eastward the depression was felt over a somewhat wider area and more markedly, and was accompanied by stormy weather of great severity, as is evidenced by the logs of the *Conflict* and *Proserpine.* The course of the former vessel is somewhat doubtful, and the observations cannot therefore be adduced with much confidence, but that of the latter vessel is much more reliable. From 8 A. M. to 4 P. M. of the 5th, the Barometer stood at 29·64* (or reduced for temperature 29·505 to 29·502), the ship being about 180 miles to the east of the storm track. The Barometer had fallen steadily (and apparently without showing the daily tides†) from the morning of the 3rd, when it stood at 29·92 (reduced 29·766). The total fall therefore was 0·264. After the minimum, the Barometer rose again gradually to the afternoon of the 7th, when it stood at 29·87 (reduced 29·732). At Chittagong there was no fall in the Barometer that can be distinctly referred to the influence of the Cyclone.

The barometric depression, therefore, extended over a distance of between 300 and 400 miles, in a direction transverse to that of the course of the storm, in the northern part of the Bay. The diameter of the vortex was, however, scarcely more than a fourth of this, as may be seen by the map.

The extent of the depression in a longitudinal direction is more difficult to ascertain; but if we reckon the whole continuous fall and rise of the Barometer at Calcutta as that of the Cyclone wave, it would appear to have lasted from the 1st to the 11th October, and therefore for a longer period than the vortex or succession of vortices existed. We have not a sufficient series of observations to ascertain the synchronous depression over the area at any given date, beyond what may be inferred from the above and the Port Blair observations, with those of the ships in the Bay. At noon on the 3rd October the Barometer at Port Blair stood at its normal height; but after allowing for all discrepancies and instrumental errors, there is little doubt that a low Barometer obtained from the position of the *Moneka* in Latitude 13° 27′ to Calcutta, a distance of 530 miles, and probably beyond in both directions.

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* See log of *Proserpine* in Appendix.

† We cannot feel much confidence in this, as the tides are very vaguely, if at all, indicated on any of the seven days over which the record extends. The instrument is probably defective.

The only series of observations on the line of the storm which are available for deducing data for the prognostication of approaching Cyclones are those of Calcutta. The barometric curves of the days, 28th September to 8th October, are shown in Plates III and IV. The rise of the Barometer previous to Cyclones has been frequently noticed, and an explanation has been suggested by Colonel Reid, and in a manner endorsed by Mr. Piddington, to the effect that "a progressive whirlwind of great extent may have the effect of arresting the usual atmospheric current, and of heaping it up to a sufficient extent on one side of the storm so as to affect the Barometer by increasing the atmospheric pressure." We cannot but think that this explanation is at variance with the observed phenomena of Cyclones, inasmuch as it proceeds on the assumption, disproved in the case now under consideration, that the Cyclone is simply a revolving mass of air, (instead of a true spiral vortex.) Moreover, in the present storm, the greatest rise of the Barometer took place a full week prior to the formation of the vortex, and there was a steady, though slow fall from the day previous to that on which the cyclonic movement commenced. We may therefore consider the atmospheric pressure indicated by the high Barometer as one of the *causes;* we cannot regard it as an *effect* of the Cyclone.

So also previous to the gale of the 26th July 1859, the Barometer stood unusually high on the 12th and 13th of the month, from which it fell pretty steadily to the day of the gale. It would, however, be hasty and unwarranted to infer from these and possibly other cases of the kind, that an unusually high Barometer always precedes a gale, as we find no indication of the kind previous to the great storms of 1842 and 1852, and we have more than once this year remarked an unusually high Barometer followed by a slow steady fall, with the wind from the east or east north-east (the Cyclone quarter), the whole terminating either in rain only, or at the utmost, in a few hours' squally weather. In 1859 the Barometer, at the end of September, was as much above the average as in 1864, but was followed by no Cyclone.

The different Barometer curves such as we have them are given on Plate VI. A great discrepancy will be observed between the two curves for Calcutta.* This is partly accounted for by the difference of the instruments, the standard being more sensitive than that observed by Mr. Cogswell, and partly by Mr. Cogswell's observations having been

* The minimum is added from a compared Aneroid observed within a short distance of the Observatory by one of the authors.

made at shorter intervals during the height of the storm, and by their being unreduced for temperature; but we cannot but consider that the 3 o'clock observation of the standard has been erroneously read or recorded, whether owing to the emotional perturbation of the observer, or other causes.

It would be idle to discuss the probable cause of the difference between the minima of the Calcutta and Barrackpore observations and that between the latter and Moisgunj, as those of Barrackpore were made with an Aneroid that has been compared and corrected only for the small ordinary daily range varying from 0·1 to 0·15 of an inch. A similar remark applies to the comparison of the Contai and other curves.

The irregular pumping motion of the Barometer during Cyclones has frequently been noticed before.* It was very marked (as mentioned at p. 40,) during the present Cyclone, and it was observed by one of us that the fall took place always *before* a squall; the lower the fall the stronger the gust that followed. It will be observed by the register of the self-recording anemometer [Plate V] that in these squalls the pressure oscillated between 5 and 32 lbs. before the vane and anemometer were blown away. Why the wind should blow in squalls instead of a steady gale is not so clear, but the above fact seems to leave little doubt that the varying atmospheric pressure indicated by the pumping of the Barometer is the immediate cause of the irregular wind pressure.

There is a noteworthy irregularity in Mr. Cogswell's Calcutta curve and in that of Moisgunj, about an hour and a half before the minimum in both cases. It is improbable, however, that these were due to the same permanent cause, as we have shown reason for believing that no vortex actually passed Calcutta, and that that which affected Moisgunj was generated in the neighbourhood of Hooghly. Nothing like the succession of waves described by Mr. Piddington (Journ. As. Soc. 1853, Vol. XXII, p. 77,) in the case of the Madras Cyclone of May 1851, is observable in the barometric records of the present storm, but our records are too imperfect to enable us to assert that they did not occur.†

An unusual feature is observable in the Contai curve, *viz.*, the extremely slow rise of the Barometer for an hour after the passage of the calm, during which the indicator of the Aneroid had remained steadily at

* See especially Piddington's Sailor's Home Book, 2nd ed. 1851, p. [illegible] where a mass of evidence on this point is quoted.

† There are some irregularities of the kind in the barometric readings of the *Clarence*. See p. 21, also Plate I and Appendix.

its violence. From Mr. O'Flaherty's description, we should infer that, during the hour subsequent to the calm, the wind was more violent than before it, but this does not appear to have been the case elsewhere, except perhaps at Koila Ghat (p. 39). From the account of the Martaban (p. 31), it would appear that immediately to the east of the central calm the barometric minimum preceded the actual passage of the centre by half an hour, but in the absence of any similar evidence from other places, we hesitate in drawing any conclusion from the data.

The *Foam* and *Chinsurah* indeed experienced a lower barometric pressure when in advance of the central calm, than afterwards, when, to judge from the direction of the wind, they were passing the centre. But they had both scudded to the westward in the interim, so that the probability is that they were really farther from the centre at the later than at the earlier hour.

B.—Hygrometry and rain-fall.

Our hygrometric data are even more deficient than those of atmospheric pressure, and comprise only the humidity observations for Kandy, Madras, and Calcutta, with an imperfect series from Balasore, and the rain-fall for a few stations in Bengal. The former have been already given in a tabular form at page 6 up to the 2nd October, and exhibit two features worthy of notice. The first, which has already been noted, is the high humidity of the south-westerly wind at Kandy of the 1st and 2nd October, not indeed, (so far as we have reason to believe,) much above what is common at the time of year, but such as would be well calculated to feed a Cyclone, other circumstances being favorable. This stormy wind continued to blow, as we have seen, on the 3rd and 4th, the humidity diminishing, however, on the latter day, as is shown by the following table; and on the 5th it had decreased to the average of the last days of September.

	October				
	1st.	2nd.	3rd.	4th.	5th.
Humidity Saturation = 100	93	94	94	90	86.

The second feature which we note, is that the humidity of the atmosphere at Calcutta, during the week preceding the Cyclone, was below

the average of the previous eleven years, and indeed below that of any year with the exception of 1857 :—

	September.				October.				
	27th.	28th.	29th.	30th.	1st.	2nd.	3rd.	4th.	5th.
Average humidity of the years 1853—63 ..	84	86	85	85	86	86	85	85	86
Humidity of 1857 ..	...	78	72	73	74	76	76	..	77
„ „ 1864 ..	80	78	80	74	78	..	73	83	90

On the approach of the Cyclone on the 4th, it rose rapidly and attained its maximum on the 5th. From this we may infer that previous to the Cyclone, the moist winds, which, at this period of the year, usually blow over Lower Bengal, had been held in check by the high local atmospheric pressure, or by the influence possibly of the northerly current, even before the latter was felt at the surface of the country on the 2nd and 3rd October. The comparative dryness of the 3rd, on which day the north-east wind prevailed at Calcutta, is very marked. At Madras the humidity of the atmosphere was even less than at Calcutta, but probably not less than is usual at the period of the year.

The following table shows the rain-fall during the storm for all the stations of Bengal from which we have received reports, classified according to their position to left, on, or to the right of the mean storm track, and in order from south to north :—

	Right.	Central.	Left.
Cuttack	....	....	0·0 inches.
Contai	....	10·*	.... „
Chittagong	0·0	....	.... „
Midnapore	....	....	4·5 „
Calcutta	1·55†	....	.... „
Moisgunj Factory	....	7·5	.... „
Comillah	2·5	....	.... „
Burdwan	....	....	4 to 6 „
Berhampore	....	....	3·43 „
Furreedpore	2·4	....	.... „
Rampore Beauleah	....	....	3·8 „
Bograh	....	7·1	.... „
Darjeeling	....	....	1·0 „
Goalparah	?60·0‡	....	.... „

* Rain gauge overflowed.

† Rain gauge at top of house, registered up to 1 P. M. only.

‡ See p. 72.

The Calcutta rain-fall appears to be very small, as compared with that of Contai, which is on the central track, or with Furreedpore, Berhampore, &c., at a greater distance from it than Calcutta; but the Calcutta rain gauge, by which the measurement is taken, is that attached to the Osler's anemometer, and is at the top of one of the loftiest houses in Chowringhee. In such a storm as the present, it is improbable that it would collect more than a small portion of the actual rain-fall, as the rain would for the most part be carried horizontally across the mouth of the instrument; a gauge situated on the ground among houses, &c., would probably show a much larger fall. Moreover, the quantity registered, is so much only as fell up to 1 o'clock, or for less than half the duration of the Cyclone. The data for estimating an average rain-fall are very imperfect, but three inches may be safely taken as within the mark for the whole storm area. This is an amount which not unfrequently falls in the 24 hours during the rains in Lower Bengal, but whether simultaneously over so wide an area as in the present case we have no data to show.

The rain-fall appears to have been greater within the area of the vortex than to the eastward; (compare Contai, Midnapore, Burdwan, Berhampore, and Rampore Beauleah, with Furreedpore and Comillah); and there was but little or no rain to the westward of the vortex, (Cuttack, Raneegunj, Sooree, Sahebgunj). It is, however, very remarkable that in the central calm of the Cyclone, instead of the torrents of rain, which usually characterize this part of the storm, there was comparatively fair weather; and the sun was seen for a short interval both by those on board the *Alexandra*, (between Saugor Island and Balasore), and by Mr. J. P. Grant at Koila Ghat.

If, then, the ascending current, which must have existed, (as inferred from the character of the wind currents feeding the Cyclone,) bears the relation inferred, on *à priori* grounds, to the rain-fall, we must conclude that this current existed over the stormy part of the vortex only, being greatest on the limits of the calm, (Contai), but not over the calm itself.

Some other cases of a comparatively clear sky over the central calm of Cyclones are mentioned by Mr. Piddington; Sailor's Hornbook, 4th Edition, p. 270.

The character of the sky during the Cyclone, over Calcutta, has been described at p. 40. The light fleecy scud flying rapidly before

the blast is such as is usual in these storms. The peculiar red light observed on the *Conflict* on the evening of the 5th, and at several places in Bengal, particularly by Captain Graham, on the night of the same day and on the morning of the 6th, will be noticed subsequently.

C.—Anemometry.

Since Mr. Redfield and Colonel Reid first turned their attention to hurricane phenomena, on no point have more diverse opinions been promulgated than on the direction of the wind currents in these storms. The oldest view, *viz.*, that suggested by Colonel Capper, and, to a certain extent, demonstrated from observations collected by Mr. Redfield, Colonel Reid and Mr. Thom, is that a Cyclone is a true whirlwind, and that the motion of wind in the storm is therefore spiral, but frequently approaching the circular. Mr. Piddington has adopted much the same view, but being apparently arrested by the difficulties of accounting for the regularity of rotation, and of getting rid of the huge volume of air which in any whirlwind must be poured in towards the centre, he has taken refuge in a number of suppositions not borne out by observation, and at variance, as it appears to us, with the known laws of pneumatics; and in a theory of the electrical origin of Cyclones, which we cannot designate either as intelligible or as consistent with what we know of electrical action.

We have had no opportunity of referring to Professor Espy's original reports, but an abstract of his theory, which was founded on a very large mass of observations, is given in Captain Maury's valuable work on "The Physical Geography of the Sea and its Meteorology,"* to which those in a similar position to ourselves may refer. Professor Espy holds† that, in Cyclones, the place of low Barometer is not circular, but "generally an oblong, in the shape of a long trough between two atmospheric waves," and that the wind does not blow around the place of low Barometer, but directly towards it. Captain Maury, in discussing the views of his predecessors, concludes that neither the theory of the cyclonologists nor that of Professor Espy is wholly right or wholly wrong; that the winds do in fact, in the first place, blow towards the place of low Barometer; and that they subsequently, in virtue of Dove's law, acquire a rotatory movement around a central point, at which the Barometer falls still lower in consequence of the ascending current above and the centrifugal motion of the wind around.

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* London, 1860. † Op. cit., p. 426.

The facts which we have detailed in the preceding pages appear to us entirely to bear out the views of Captain Maury, for the masterly exposition of which we must refer the reader to the original work (p. 433). We have shown (*ante* p. 76) that there is good reason to infer, that previous to the formation of the Cyclone, a place of low Barometer existed in the central region of the Bay of Bengal, the barometric pressure at Calcutta being at the same time unusually high, and about the same as the *sea-level* pressure at Kandy; that a strong, nearly saturated south-westerly current* set in immediately afterwards towards the place of low Barometer, and that at the same time a northerly wind was blowing in Eastern Bengal, which, in the first days of October, gradually extended over the region to the north and west of the Bay. The latter current was not therefore established until after the formation of the Cyclone, to which it contributed only in an insignificant degree. The real origin of the Cyclone appears to have been the curvature of the south-westerly current, which, having reached the place of lowest Barometer, and its progress being there arrested, became rotatory in accordance with the law already frequently referred to.

The first vortex formed (on the 2nd October) appears to have progressed but a short distance, but the south-westerly current still pushing onwards up the Bay, formed a second vortex (on the 3rd) about 200 miles to north north-west of the first. There may indeed have been several vortices formed on these and the succeeding days, and that such was the case, is by no means improbable. Our data only warrant the conclusion that the Cyclone of the 3rd was not the same vortex as that of the 2nd.

On the 3rd and 4th October the southerly current pushed its way further up the Bay, producing the stormy weather experienced by the *Conflict* and *Tubal Cain*, recurving from the Arrakan Hills, and thus becoming an east north-easterly and easterly current in the northern part of the Bay, and (on the 4th) in Lower Bengal, and forming an advancing vortex or series of vortices along a line at first north north-west, and subsequently north in direction, up to the mouth of the Hooghly. The prevalence of stormy weather over the eastern half of the Bay, (to east of the vortex), and the comparative calm to the westward of the vortex, are in accordance with what we have inferred on other

* The wind had been steadily south-west, and west south-west for many days previously at Kandy, but a gale of greater strength took place at the time mentioned.

grounds, as to the almost exclusive dependance of the Cyclone on the strength and moisture of the southerly current. The average rate of progress of the vortex up the Bay was about 220 miles a day, or about 9·1β miles an hour.

It is from the observations made during the passage of the storm over Bengal, that we obtain the most valuable and detailed data for educing the peculiar characters of the vortex. The general track was, as we have seen, over Contai, Tumlook, Koila Ghat, Santipore, Kishnagur, Mehurpore, Nattore, and Bograh, after which the vortex rapidly diminished, and appears to have broken up, or at least lost its well-defined cyclonic character, along the escarpment of the Garrow hills; although a storm of considerable violence raged subsequently in Lower Assam. Its average rate of progress through Bengal, from the coast to Bograh, (250 miles,) was 15¾ miles an hour, and therefore much greater than in its course up the Bay. It was, however, very irregular, being only 6½ (possibly only 4½) miles an hour between Tumlook and Koila Ghat, and 9 miles an hour between Santipore and Kishnagur. There is no sufficient evidence that the actual progression of a vortex ever exceeded 10 miles an hour, but we have shown good reason to believe that in cases of apparently greater velocity, a new vortex was in reality forming several miles in advance.* Our data have not admitted of our detecting more than three such vortices, (one between Tumlook and Koila Ghat, one between Hooghly and Mehurpore, and one north of the Ganges,) but it is far from improbable that the number may have been greater. These vortices, however, whatever may have been their number, occurred successively, and on the same general line, or nearly so, and there is no evidence of any secondary vortices to east and west of this line, or of the co-existence of two Cyclones for more than an hour or so. The line of their path may be defined as the limit between the recurved southerly current and the comparatively still atmosphere or the northerly current to the westward.

These facts suggest an explanation of the causes which determined the course of the Cyclone, which course was, as we have shown, and as may be seen on reference to the accompanying map, Plate I, first north north-west, then due north in the northern part of the Bay and over Bengal as far as Koila Ghat, and finally north north-east.

* Compare the remarks of the late Admiral Fitzroy :—"Weather book, pp. 112-211."

The first rush of the south-westerly current to the place of lowest Barometer in the neighbourhood of the Andamans having formed a vortex, and thus an ascending current, was followed by a further diminution of atmospheric pressure over the vortex, (see ante p. 76), and this in its turn by an increasing current from the southward. This current, recurving from S. W. to S., S. E., and E., advanced gradually northwards, establishing itself over the whole north-eastern part of the Bay, and as it acquired increased force, it forced aside, and to the westward, the mass of comparatively still atmosphere, into the bosom of which it had made its way.* The vortex formed on the western limit of the recurvature would thus move to the north and west, and would continue on this course so long as the southerly current was of sufficient force to push its dominion further westward as well as northward. When, however, its force was so far reduced as to bring it into equilibrium with the lateral pressure of the surrounding atmosphere to the west, the course of the vortex would be northward, and finally, with the gradual exhaustion of the southerly current, the vortex would assume a somewhat north-easterly course.

We offer this explanation as applicable to the present storm only, a storm in which the polar current was weak and comparatively unimportant. But we think that by modifying the circumstances the course of other storms may be equally well explained. Had the northerly current been stronger, it is clear that it must have modified considerably the course of the Cyclone, turning it more to the westward. A case very different from the present, is the storm of June 1839, recorded by Mr. Piddington in his first Memoir on the Law of Storms, (Journal Asiatic Society, Bengal, Vol. VIII., pp. 559, 631,) and discussed by Professor Dove in his 'Gesetz der Stürme.'† In this case a vortex originated at the curvature of a stormy south-westerly current impinging on the coast of Arrakan, and thence diverted (in a manner similar to the present, but more abruptly) to west north-west and west. The vortex in this case travelled to west south-west across the Bay, a very unusual course.

The course of the wind in the vortex is shown in Plate I, which gives the synchronous wind observations for noon of the 5th, at which time the central calm was passing over Tumlook. It is not pretended

* It is not improbable that the mountains of Arrakan from 2,000 to 5,000 feet in height have a considerable influence in determining the recurvature of the south-westerly currents in the Bay of Bengal, although, as has been shown by Professor Dove, such a recurvature would be produced in a still atmosphere over a level country or sea.

† 2te. Aufl. p. 133.

that these are other than approximations to accuracy, and it is very probable that many of them may be two or three points in error, but after making every allowance, it is clear that the wind direction is everywhere mainly converging, except within 15 or 20 miles of the central calm, the convergence being in a very abrupt spiral. Having protracted a series of similar charts for different hours of the 5th, we find that the same character holds good throughout, and that circular or nearly circular currents, such as are usually represented by Mr. Piddington, formed but a small part of the storm, not exceeding 50 miles in diameter. Even in this, the spiral motion of the wind current still obtains, (to judge from such observations as we have,) but it approaches a circle (or ellipse?) sufficiently to allow of the tangential direction of the wind being assumed for all practical purposes.

There must, therefore, be a great ascending current, as there is no centrifugal movement of the lower atmosphere to compensate the centripetal currents, the existence of which our data prove. This upward movement of the atmosphere probably obtains over at least the entire vortex and even beyond it, and indeed that it does so exist appears to be proved by the permanence of a low atmospheric pressure.

The form and dimensions of the central calm can only be approximately ascertained. Even if we assume that its greatest antero-posterior diameter passed over Contai, Tumlook, and Koila Ghat, we cannot calculate its length with confidence, on account of the proved irregularity of the storm's progress, and the doubt which attaches to the recorded hour of its passage over the last-named place. The same observation applies to the passage over Santipore and Kishnagur, where the Kishnagur data are open to much question. All we can do therefore is to make the extreme assumptions allowed by our data in both cases, and draw the best conclusions we can from the whole.*

From the sounding taken by the *Alexandra* during the passage of the calm, we may infer that she was then not more than 12 or 15 miles from the coast, or about 20 miles from Contai. The calm occurred at about 8 or 9 (mean 8 h. 30 m.) at the ship, at quarter to 10 at Contai,

* It is true that we here discuss the phenomena of two or more different vortices, but the strength of the producing currents being the same, or nearly the same, in the two cases, no error can arise, greater than is inseparable from the primary conditions of the calculation.

giving a rate of progress of 16 miles an hour. The calm was three-quarters of an hour passing the *Alexandra*, and thus we obtain for this observation a diameter of 10·3 miles.

The distance of Tumlook from Contai is 37 miles, and at the latter place the calm commenced at noon, indicating a rate of 16 miles an hour, or the same as before. As the passage of the calm over Contai lasted 1¼ hours, this would give 20 miles as its diameter for that place. We have, however, before given our reasons for doubting whether the vortex ever progressed at so great a rate as 16 miles an hour, and we should rather conclude from the above, that the Contai vortex was not the same as that at Tumlook, than that the diameter of the calm was as much as 20 miles.

Between Tumlook and Koila Ghat the rate of progress was probably 6½ miles an hour, the calm was rather more than half an hour passing the former place, and an hour passing the latter. This would give about 3½ miles diameter for the former and 6½ for the latter.

Between Santipore and Kishnagur we have deduced 8⅔ miles an hour as the rate of progress. It was about three-quarters of an hour passing over each of these places, and thus we have again a diameter of 6½ miles.

The several diameters thus deduced may be tabulated as follows:—

Alexandra	...	...	...	10·3 miles.
Contai	...	...	...	20 „
Tumlook	...	...	...	3·5 „
Koila Ghat	...	...	...	6·5 „
Santipore	...	...	...	6·5 „
Kishnagur	...	...	...	6·5 „

If then we reject the *Alexandra* and Contai calculations as being both based on a rate of progress incompatible with our general results, and infer that Tumlook lay a little to the side of the central track, we have an antero-posterior diameter of 6½ miles as the nearest approximation we can make to the truth. We must confess, however, that it is far from satisfactory, and it is quite possible that the dimensions of the central calm may be as variable as the above numbers would indicate.

The transverse diameter may be ascertained with somewhat more certainty, though here again we have great discrepancy. Assuming, as we may fairly do, that the centre of the calm passed over Contai, we

ad that there was a sudden and entire lull (a little after 10 A. M.) at owcolly, 13 miles to the eastward. This would give a transverse dia- eter of 26 miles. But we have also seen that about the time of the assage of the calm over Kishnagur, there was also a lull of a few inutes at Moisgunj, 8 miles to the west. If then Kishnagur lay, s we have assumed, on the central line of the storm track, the transverse iameter would be 12 miles only, and that it could not be much greater proved by no calm (not even a partial lull) having been felt at Bug- oolah station, 10 miles to the east of Kishnagur.

Our data for estimating the force of the wind are scanty in the xtreme, and we fear not very reliable. The register of the self-registering nemometer at the Surveyor General's Office, Calcutta, is given on Plate V, from which it will be seen that the greatest pressure of the gusts at 1 o'clock was about 32 lbs. to the square foot, equal to a velocity of 80 miles n hour. The greatest force of the storm was, however, not until half-past 1 or quarter to 3, and if we suppose that the force increased up to this time n the same ratio as had obtained from 3 A. M., *viz.*, at about 2·7 lbs. per iour, the maximum would be 36 lbs. = 85 miles an hour. But it is evident rom the register, that the increase was most rapid after 11 o'clock, so hat the real maximum was probably much higher than this estimate. A calculation for which we are indebted to Colonel Douglas, the Director General of Telegraphs, based on the pressure required to overthrow a solid brick pillar, which was blown down at the E. T. Workshops at half-past 1, gives 37·34 lbs. at that hour;* or an increase of 3·34 lbs. in half an hour. At this rate the maximum at half-past 2 would be 42lbs. to the square foot = 91½ miles an hour. It must, however, be remarked that the estimate of some of the more experienced ship-captains in port is much higher.

We have noticed that the trees began to fall in Calcutta about 11 or 12, when the pressure of the strongest gust was about 20lbs. to the square foot. It was after 12 that the greatest destruction took place. It will not perhaps be too much to assume that a minimum of 15lbs. to the square foot prevailed over the area of destruction; and this we have shown to extend 35 to 40 miles to the westward of the mean central track, and about 50 miles (Jessore) to the eastward. The total diameter of the track of destruction was therefore not more than between 80 and 90 miles.

* The calculation assumes a non-vibrating mass, and makes no allowance for the cohesion of the mortar, so that it can only be regarded as an approximation.

Were our data more reliable, we might go on to calculate the velocity of the circular current in the different parts of the storm, and thus attempt to ascertain that of the ascending current, but having had to assume so much, the results would be of little value, and we can only hope that in a future visitation of the kind, more reliable and more numerous observations may be forthcoming to allow of such a calculation.

We have finally to notice the irregularities of the wind currents, which we have more than once adverted to, and to point out their peculiarities, and their connection with the oscillations of the Barometer. It appears to be a common, if not universal, feature of violent and stormy winds, to blow not continuously and steadily but intermittently and in squalls, but in Cyclones this is so marked that it cannot escape observation; the anemometer shows that, previous to the storm of October last, the wind began to blow irregularly and in gusts, simultaneously with its veering to the east, and with the commencement of the rain between 7 and 8 P. M. of the 4th; that as the average force of the wind increased, so the irregular gusts became more frequent, but up to 1 A. M. of the 5th the pressure did not vary more than 1 lb. to the square foot in the gusts, and the direction of the wind vane was not affected by them. After this the vane began to oscillate irregularly, and when the average variation of pressure in the gusts was from 2 to 3lbs., the oscillations of the vane were synchronous with them. At a subsequent hour the wind veered through four or six points at each squall, and, as would appear from the register of from 3 to 5 A. M., veering first to the north and then returning to its previous direction. We are unable to say from actual observation whether the veering was always in the same direction or not. Taking these facts in conjunction with the oscillations of the Barometer, already described, and bearing in mind that the Barometer fell *before* each squall, and, so far as could be judged, in a measure proportionally to the violence of the squall that followed, their explanation is pretty evident; for a sudden diminution of the atmospheric pressure must be followed by rush of wind, and this air current forcing its way into a mass of air moving with comparatively small velocity must produce eddies, such as are indicated by the veering of the vane. Such at least we take to be the immediate cause of the squalls, and of the veering of the wind vane. The cause of the irregularity of Barometer pressure is not so evident.

D.—Electrical Phenomena.

One of the most remarked negative features of the present storm was the absence of thunder and lightning. This peculiarity is specially noticed by Captain Smart of the *Chinsurah*, and Mr. Baker at Hooghly, and, with the exception of the logs of those ships that witnessed the commencement of the storm, and one or two accounts from places at or near the eastern limits of the storm current, and far from the cyclonic vortex, no account received by us mentions any occurrence of disruptive electrical discharge. But we cannot refer to other than electrical action, the luminous appearances noticed by many observers on the night of the 5th, and especially that so graphically described by Captain Graham as observed on the Jhenai River. These have already been described in the foregoing detailed account of the progress of the storm, but we shall here briefly summarise them as a preliminary to the discussion of their cause and nature.

Lightning was observed by the *Conflict* on the night of the 1st and 2nd October, and also by the *Golden Horn*, and the *Moneka* noticed lightning to the north north-west, on the afternoon of the 2nd. On the 3rd, at midnight, the *Proserpine* observed lightning to the eastward, and on the afternoon and evening of the 4th a storm accompanied by lightning and thunder passed over Chittagong and Burrisaul. All these cases were at the commencement, or on the outer limits of the storm. After the passage of the Cyclone, and far in its rear, the *Sydenham*, *Golden Horn*, and *Conflict* observed lightning in the north of the Bay on the 5th October, but none was observed or at least recorded at any station in Bengal. At Dacca alone, distant thunder was heard.

The luminous appearances observed on the night of the 5th at Calcutta (to the northward) at Kooshtee and in the neighbourhood (chiefly to the westward), at Nattore, Dadupore, and Jumalpore, and by Captain Graham on the Jhenai River, and which by many were attributed to the burning of villages, are, we think, undoubtedly electrical manifestations. So also possibly the red sky observed on board the *Conflict* on the evening of the 6th. That villages were in some cases burnt by the huts being blown down on the fire usually kept burning in native houses is not improbable, but there is no mention of any general destruction of this kind in the reports we have received, and the peculiarities of the light observed by Captain Graham, where it followed the changes of the wind round the horizon, "being sometimes high and sometimes low in

the heavens," and finally breaking out "in great splendour in the south-west, lighting up the whole sky and appearing like the sun breaking through murky clouds at mid-day," are sufficient, we think, to prove, that the supposed conflagrations are insufficient to explain the whole of the phenomena in question, if indeed they be in any way connected with them. On the other hand, we have in the glow discharge of electricity a consistent explanation of the phenomenon: one which seems to account for the absence of lightning in an atmosphere which must (judging from all analogy) be highly electrical; and which finally, if not very common as an atmospheric phenomenon, has been observed with sufficient frequency to admit of its acceptance as a *vera causa*. Next to lightning, (the disruptive discharge) the phenomenon known at various times and places as Castor and Pollux, St. Elmo's fires and *comazants* (the brush discharge) has been most frequently observed, but many well known cases of the glow discharge are on record, in luminous fogs (such as that of 1783), in luminous clouds, &c., and in volcanic eruptions,* although, so far as we are aware, the light exhibited in the present and some tropical Cyclones previously on record,† has never been distinctly assigned to the same class. It may be a question whether the rushing noise mentioned by some observers as preceding the furious rush of the Cyclone be due to electrical discharge or not, but we may note that many authors attribute the somewhat similar noise noticed on the approach of violent hailstorms to an electrical discharge, and a similar phenomenon has also been noticed in snow storms under circumstances which seem to admit of no other explanation than that of electric discharge.

The balls of fire observed by some natives in the neighbourhood of Kooshtee, and also at some places north of the Ganges, are a sufficiently well known form of atmospheric electric discharge to render discussion unnecessary.

Sir John Herschel has pointed out that the negative electricity of the atmosphere during rain-fall is not improbably due to the friction of the falling rain drops. In Cyclones such as the present, the enormous friction of the wind-borne rain against terrestrial objects must be a powerful generator of electricity, the rush being comparable with that of an escaping jet in one of Mr. Armstrong's hydro-electric machines, but on a vastly greater scale. It is much to be regretted that the Calcutta

* See 'De la Rive,' Treatise on Electricity, English Edition, Vol. III., page 168.

† Piddington, Sailor's Horn-Book, 4th Edition, page 214.

Observatory, being unprovided with electrical instruments, no observations could be made on the actual electric condition of the atmosphere, but we suggest this point for future investigation.

After what we have written respecting the probable causes of the Cyclone, it appears unnecessary to discuss the theory enunciated by Mr. Piddington of the electrical origin of these storms. We may content ourselves here with pointing out that Sir John Herschel and the best later writers have given strong reasons for regarding electrical condensation and discharge as an *effect* of the formation and fall of rain, and the further cause we have suggested above, is one which demands the pre-existence of a violent wind current, to which it stands in like manner in the relation of an effect. We cannot express our own opinion better than in the words of Sir John Herschel, "*As a cause of wind, or any atmospheric movements not wholly molecular, we attribute to (electricity) no importance whatever.*"*

ON THE PROBABLE LAWS OF CYCLONES IN THE BAY OF BENGAL.

We have now concentrated the data of our record to something like definite conclusions for the storm under discussion. To attempt the further step, an induction of laws supposed to be applicable to all cyclonic storms in the Bay of Bengal, from the phenomena of a single Cyclone, would of course be inadmissible, and the facts of previous storms within the same area are either insufficient, or have not in general been digested in a manner, to enable us without more prolonged study than we are now able to devote to them, to collate them with those given in the previous pages, and thus lay a basis for the induction† of the laws of causes. It is, however, possible, from a review even of the data before us, to suggest certain important facts and phenomena to which in future special attention may be directed with a view to determine whether they are of general or casual occurrence in connection with Cyclones, and to what degree, therefore, they may be accepted as laws or indications of the approach or probable occurrence of the latter, and of their probable course.

* Meteorology, page 132. Italics in the original.

† We trust, however, at some future time to be able to undertake the duty of reviewing, with reference to the conclusions of the present report, the data so laboriously collected by the late Mr. Piddington, and published in *extenso* in the Journal of Asiatic Society, a his numerous Memoirs on the Law of Storms.

And first as to the periodicity of the Cyclones of the Bay of Bengal. If, as in the present case, Cyclones are, as it is not unreasonable to assume, generally, if not always, produced by a sudden inrush of a nearly saturated mass of air from the southwards* to a place of low barometer in some part of the Bay of Bengal, theory would indicate the end of the south-west monsoon as affording the most favorable conditions for their formation. This will appear from the following considerations, the facts of which we derive mainly from Captain Maury's work on Meteorology.

During the height of the south-west monsoon, the average barometric pressure at Calcutta, as shown both by Captain Maury's investigations and by Baboo Rajakaunt Sein's Summary of five years' observations at the Calcutta Observatory, is 29·55 inches,† while at Madras

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* A northerly current in the Bay of Bengal comes from the dry cold region of Central Asia. It gathers indeed some moisture in passing over the Bay of Bengal, but its comparative dryness is proved by the small rainfall of the Coromandel Coast during the north-east monsoon; and if the views of Professor Espy, Captain Maury, and indeed most meteorologists, on the part played by atmospheric moisture in the production of Cyclones, be correct, there is reason for grave doubt whether such a wind as the north-east monsoon of the Bay of Bengal *could* produce a Cyclone. Professor Dove gives the following rainfall for four stations on or near the Coromandel Coast, during the north-east monsoon months [October to March].

	Altitude.	Inches.
Vauriour	60 feet	16·48
Palamcottah	200 „	16·25
Shenkottah	600 „	20·70
Madras	20 „	31·67

But by no means the whole of the above can be attributed to the north-east wind, as the Cyclones of October and November are partly, if not mainly, fed by southerly winds. Indeed we should infer from the fact that the greater part of this rainfall is in the months of October and November, when the monsoons are changing, and but little from December to March, when the north-east wind prevails, that the greater part of this rain is brought by southerly winds. The following table shows this:—

	Oct.—Nov.	Dec.—March.
Vauriour	10·77	5·71
Palamcottah	9·06	7·19
Shenkottah	13·41	7·29
Madras	23·64	8·03

† The average barometric pressure for each month deduced from the observations of the 5 years, 1858-62, is as follows:—

January	30·000	July	29·535
February	29·942	August	29·590
March	29·857	September	29·685
April	29·761	October	29 801
May	29·638	November	29·950
June	29·546	December	30·006

it is 29·73, and at the Equator 29·92. The yearly variations in the equatorial pressure are so small as to be negligible, but at the change of the monsoon in October or November, (varying in different years,) the Calcutta Barometer stands at the same height as that at the Equator, and hence indeed the cessation of the south-west monsoon. The monsoon ceases to blow first at its northern limits, and after a period of variable winds, the north-east monsoon sets in first in that quarter, and gradually progresses southwards, (according to Captain Maury) at the rate of fifteen to twenty miles a day.

This gradual advance of the north-east monsoon southwards, is, however, by no means regular. Captain Maury's statement refers to the averages of many years,* and the advance southward is therefore a *tendency* only amid a long series of changes, the more important of which we shall presently notice. The following must also be understood not in a literal sense, but with a similar modification to the above:—

* The following important table, constructed from the comparison of 11,697 observations on the winds at sea between the meridians of 80° and 85° east, and from Calcutta to the Equator, exhibits the data upon which Captain Maury's description is based.

	22° and 20° N.		20° and 15° N.		15° and 10° N.		10° and 5° N.		5° and 0° N	
	Days.	Days.	Days.	Days.	Days.	Days.	Days.	Days.	Days	Days.
	N. E.	S. W.	N. E.	S. W.	N. E.	S. W.	N. E.	S. W.	N. E.	S. W.
January ...	17	6	21	2	23	1	20	1	19	3
February ...	11	11	13	6	10	3	22	1	18	2
March ...	4	18*	7	15	18	5	13	0	15	2
April ...	2	24	2	22*	6	12	6	11	4	14
May ...	1	26	1	24	3	21*	1	23*	0	19*
June ...	0	28	1	27	0	29	1	25	0	24
July ...	2	24	1	27	0	30	0	28	0	24
August ...	0	28	1	24	0	24	1	22	0	18
September ...	6	14	1	18	0	23	0	26	1	18
October ...	9	6†	12	0†	8	10	6	16	4	14
November ...	11	6	25	2	21	2†	10	6	5	14
December ...	27	0	26	1	24	1	15	8†	12	11

* Setting in of south-west monsoon. † Ending of south-west monsoon.

Captain Maury further states, that the winds blow towards a place of low barometer, which (we infer from the context) he appears to regard as progressing gradually southward. That such is the case, seems probable from the facts above quoted with regard to the wind currents, but we have no data before us sufficient to prove it. The *monthly averages* of a number of Stations given by Professor Dove in his 'Gesetz der Stürme' are insufficient for the purpose. Captain Maury's deductions are, however, founded on the discussion of a very large number of ship observations, and the high reputation of the author, warrants our receiving his statement with respect. In any case, at the end of the south-west monsoon, a strong but irregular southerly or south-west wind blows in the southern part of the Bay for some weeks, after it has ceased to blow in the northern part of the Bay and Bengal, and an unusually strong current may therefore pass unimpeded into the comparatively tranquil mass of atmosphere in the central or northern part of the Bay, thus fulfilling the conditions requisite for the formation of a Cyclone.

The following list of recorded Cyclones in the Bay of Bengal, notwithstanding its undoubted imperfection, may be accepted as a proof of the justice of the above conclusions with regard to periodicity. It shows that though Cyclones occur at both the periods of changing monsoon, they are far more numerous at the close of the south-west monsoon than at its commencement.

Years.	Total.
January, 1805	1
February	0
March, 1820	1
April, 1840, 1850, 1851	3
May, 1787, 1811, 1814, 1820, 1823, 1833, 1834, 1841, 1843 [2], 1849, 1852 [2],	13
June, 1822, 1839, 1842	3
July, 1848, 1859	2
August, 1834, 1835	2
September, 1839	1
October, 1737, 1800, 1818, 1831, 1832, 1836 [2], 1838, 1842 [2], 1848, 1851, 1864 [2]	14
November, 1797, 1815, 1838, 1839 [2], 1843, 1844, 1845, 1850, 1864, 1865 ..	11
December, 1803	1
	52

Nearly half the recorded Cyclones of the Bay of Bengal have occurred, therefore, at the close of the south-west monsoon, in the months of October and November. Of the remainder, more than two-thirds (19 of 27) have occurred at the commencement of that monsoon. From Captain

Maury's description of the barometric condition of the atmosphere at this latter period, it might seem difficult to account for the occurrence of Cyclones in May, June, &c., on the fundamental supposition that they are produced by an inrush of a southerly current to a place of low barometer; but, as in the case of the opposite change, the description given by Captain Maury can only be admitted as a graphic representation of an average result, not that of a simple obvious phenomenon. Though true, as is shown by the table given in the note on page 96, its truthfulness is masked by the interference of other phenomena with the steady march of a great barometric wave such as is described.

The main fact, then, that appears to determine the formation of Cyclones, especially at the periods of changing monsoon, is, that the wind is then variable instead of steady, and thus, while, on the one hand, a saturated or nearly saturated atmosphere is accumulated over the Bay of Bengal, on the other hand, a sudden inrush of air towards a place of low barometer is checked by a mass of comparatively quiescent air, and a great eddy produced, which rapidly becomes a Cyclone. The greater frequency of Cyclones at the end of the south-west monsoon may then be attributed to the *tendency* to low barometric pressure over the Bay at that period, as contrasted with the *tendency* to high barometer at the opposite change of the monsoon, as above specified.

The second class of periodic variations which appear to determine the occurrence of Cyclones, is that of the alternations of barometric pressure, the so-called *atmospheric waves*, which observation has shown to take place simultaneously along the same meridian,† and which have been referred by Professor Dove to alternations of northerly and southerly currents in extra-tropical regions,‡ or in the upper atmosphere.

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* "The south-west monsoons commence at the north, and back down, or work their way towards the south. Thus they set in earlier at Calcutta than they do at Ceylon, and earlier at Ceylon than they do at the Equator. The average rate of travel, or "backing down to the south," as seamen express it, is from fifteen to twenty miles a day. It takes the south-west monsoons six or eight weeks to "back down" from the Tropic of Cancer to the Equator. During this period there is a sort of barometric ridge in the air over this region, which we may call the monsoon wave. In this time it passes from the northern to the southern edge of the monsoon belt, and as it rolls along in its invisible but stately march, the air beneath its pressure flows out from under it both ways—on the polar side as the south-west monsoon on the equatorial as the north-east." Maury's Phys. Geog., &c., page 373.

† See especially Daniell's Meteorological Essays, Vol. 1, page 364.

‡ Fitzroy's Weather-book, pp. 35, 70, 72, 95, 296.

These waves are very marked, usually varying in duration from three or four to twelve or fourteen days from crest to crest, and appear to be most decided at the times of change of monsoon. The total rise and fall of the Barometer at Calcutta, during one of these waves, is from one-tenth or less to two or sometimes, though rarely, three-tenths of an inch. It was during the passage of one of these that the Cyclone of October last occurred. The fall, as we have shown (p. 3,) began on the 26th September, and after a slight rise on the 30th of that month and the 1st October, reached its minimum on the 5th, after which the Barometer rose pretty steadily up to the 18th of the month. The wave was therefore of unusual length, but something of the rise must be attributed to the great annual oscillation already described.

So far as we have yet examined the records of past years, Cyclones appear to occur only at the passage of the trough of one of these barometric waves, but further examination is requisite to establish the fact as a meteorological law.

It results from Professor Dove's investigations, that the fall of each wave indicates a strengthening current from the south, while the rise indicates one from the north, the whole system of parallel and alternate opposite currents, progressing gradually from east to west. If then our attempted generalizations should be found to hold good on further enquiry, it would show that an increasing southerly current is a forerunner of Cyclones generally, though it, of course, by no means follows that every such current should produce a Cyclone—a supposition entirely negatived by every day experience.

Our data then indicate two probable laws of periodicity, one of which is open to little doubt, while the other requires further investigation to establish it. These are—

I.—That Cyclones occur in the Bay of Bengal, with greatly preponderating frequency in those months in which the monsoon is changing, *viz.*, in the latter part of April, May, and the beginning of June, and in October and November; being more frequent at the latter period than at the former.

II.—That they occur where a gradual fall of the Barometer indicates a strengthening current from the south.

It is further worthy of enquiry, whether, as was the case in the late Cyclone, storms originating in the central part of the Bay are not usually

preceded by a south-west or west south-west and highly moist wind in Ceylon; a supposition which we have not at present the means of testing satisfactorily, but which, if true, will render the Kandy observations, now transmitted daily by Mr. Barnes to Calcutta, of very great value, as warning us of approaching hurricanes, which may not be felt as circular storms in Ceylon or Southern India.

With respect to the place of origin and course of the Cyclones of the Bay, we obtain some information of importance from the charts of former Cyclones, which we owe to Mr. Piddington's long and laborious researches. It is apparent on a glance at the Cyclone chart for the Bay of Bengal,* that with one or two exceptions, the course of storms originating in, or traversing the northern part of the Bay is between north-west by west and north by west; while the usual course of those in the southern part of the Bay is between north-west and west. Setting aside the Andaman Sea (*i. e.*, the Bay between the Andaman Islands and the Tenasserim mainland), the storms of which are generally quite local, it appears that there are three principal foci, from which the Cyclone tracks radiate. The first, which we may call the northern focus, is situated a little to the eastward of the middle of that part of the Bay north of Cape Negrais and the Godavery: the second, which we may term the Andaman focus, is in the immediate neighbourhood of the islands of that name, usually a little to the west or north-west of the Group: the third, which we may call the southern focus, is about midway between Ceylon and the Nicobar Islands. Of the 20 recorded storms, the origin of which has been pretty clearly traced to their foci, the following analytical table shows the distribution in the different months of the year:—

Originating at	January.	February.	March.	April.	May.	June.	July.	August.	September.	October	November.	December.	Total.
Northern focus ...	...	...	...	...	2	3	...	...	1	4	...	...	10
Andaman ,, ...	...	...	...	...	2	...	...	...	...	1	1	...	4
Southern ,, ...	...	...	...	1	2	...	...	...	...	...	2	1	6

* Piddington's Sailor's Hornbook.

Hence it appears that, at the beginning of the south-west monsoon, storms originate in the southern part of the Bay earlier than in the northern part, while at the close of the south-west monsoon they occur first in the north of the Bay. The above table enumerates but 20 storms, and may therefore be considered insufficient to warrant the above inference as a general law. We obtain, however, similar results, if, instead of tabulating storms according to their ascertained place of origin, we tabulate them as chiefly affecting the northern or southern part of the Bay and their respective coasts, a line from Cape Negrais to the mouth of the Godavery being assumed as the boundary. We include storms, (such as that of October 1864,) which commence near the Andamans and proceed northwards, in the northern division.

Storms in	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Northern half ...	...	...	...	...	6	3	2	2	1	9	2	...	25
Southern half ...	1	...	1	3	6	...	...	...	...	6	8	1	26

Thus, then, there is no instance on record, in the works we have consulted, of a storm in the northern part of the Bay between the months of November and May, and no instance of any in the southern half in February, or in those months in which the south-west monsoon is at its height, *viz.*, between the months of May and October.

Such being the facts of periodicity taken in connection with locality, it remains to obtain their rational explanation by comparing them with the laws of the changing monsoons, as elicited by Captain Maury. In instituting this comparison, it will be convenient to consider successively the meteorological phenomena of the four periods; (I) of the south-west monsoon, (II) of the change from south-west to north-east monsoon, (III) of the north-east monsoon, and (IV) of the change from north-east to south-west monsoon.

I.—The south-west monsoon, like all periodical winds, blows with least force and steadiness near its limits. It is true that, as a rule, southerly winds prevail pretty steadily at Calcutta during the south-west

monsoon months, but a northerly wind is sometimes felt (once or twice in each month), usually for a few hours only, rarely for one or two days. The average lowest barometric pressure is on the northern limit of the monsoon during the monsoon months. This is assumed to be in latitude 30° north, where the mean pressure for those months is 29·45 inches, that at Calcutta being 29·55; but as in the case of the change of monsoons already discussed, this represents an average only, not a constant fact, and there may be, and frequently is, a lower barometric pressure in somewhat lower latitudes, than that at the assumed average limit of the monsoon. This, however, occurs the less frequently, the farther we proceed southward. These facts suggest a rational explanation of the two facts we have to deal with, *viz.*, that Cyclones occur but rarely in the south-west monsoon months, and then only in the northern part of the Bay: we have already premised that we can but suggest explanations at present, to be tested by future investigations.

II.—At the change of the south-west to the north-east monsoon in October and November, Captain Maury has shown that the change begins at the northern limit of the monsoon area, and progresses gradually southwards. As a consequence of this, the line of separation of the two winds, towards which both blow, and the average place of low barometer also progresses southward. During this period storms occur in all parts of the Bay, but on an average follow the same law of progress as the boundary of the monsoons and the place of average low barometer, that is, they are more frequent in the northern part of the Bay during the beginning of the change, (*viz.*, October,) and in the southern part of the Bay during the latter part of the change, (*viz.*, November.)

III.—During the height of the north-east monsoon, the average limit of the monsoon is, as shown by Captain Maury, in about north latitude 3°; the place of low barometer being the equatorial belt of calms. It is not clear that Cyclones ever originate in a lower latitude than 5°, but such as occur during the north-east monsoon months are, (so far as our records show,) invariably in that part of the Bay which is nearest to the calm belt. Thus the December storm of 1803 and the January storm of 1805, were felt in Ceylon, and that of the 28th November and 2nd December 1843 originated about north latitude 5°. The place of origin of the two Ceylon storms is not on record, but to judge from the recorded tracks of the Cyclones of the southern part of the Bay, they probably came either from the east or east south-east.

IV.—It is at first sight more difficult to reconcile the distribution of storms at the change of north-east to south-west monsoon with the laws of the monsoons than in the cases we have already discussed, seeing that the south-west monsoon first commences in Northern India and progresses southwards, and that during the change the line of demarcation is one *from* which both monsoons blow. It must be remembered, however, that the Barometer is sinking over the whole of the monsoon region during the change, but only more rapidly and somewhat earlier in the northern than in the southern part of the area, so that at the middle of the change the difference of *average* barometric pressure over different parts of the Bay is but small. In the month of April there are calms or weak northerly winds in the south part of the Bay, (see Table, p. 96), and a strong inrush of a southerly current, such as we believe to be in all cases the generator of Cyclones, would be checked by this weakly blowing or stagnant mass of air, and produce a Cyclone. In May the southerly monsoon prevails over the whole of the Bay, but until the rains of Bengal have commenced, it blows with but little regularity.* During this month, our storm table shows that storms occur with equal frequency in all parts of the Bay. As the monsoon gains in strength, the Cyclone site is transferred to the northern part of the Bay, and thus the recorded Cyclones of June are all in this region. Cyclones become less common with the strengthening monsoon, and we then return to the conditions discussed in paragraph I.

We have already suggested at page 87 the probable causes that determine the track of Cyclones, and we think that the tracks recorded by Mr. Piddington, taken in connection with what we have said above, tend strongly to bear out our conclusion. Thus, Cyclones of the extreme southern part of the Bay tend westward, rather than northwards, because at the period at which they chiefly occur, the north-east monsoon is at its height, (December, January.) Those which originate in the north of the Bay move between north-west and north by west, because at the period of their occurrence the south-west wind predominates, and is but weakly opposed by a northerly current. The annexed diagram, in which the comparative strength of the northerly current is represented

* In the north-east corner of the Bay, the southerly monsoon blows strongly in March and April, owing probably to the influence of the Khasia and Garrow Hills. North-westers are very common at Backergunge in these months, but less frequent to the westward, and in Calcutta they are rare before the latter end of April or May.

by the different lengths of the arrows, may seem to render this idea more clear to our readers.

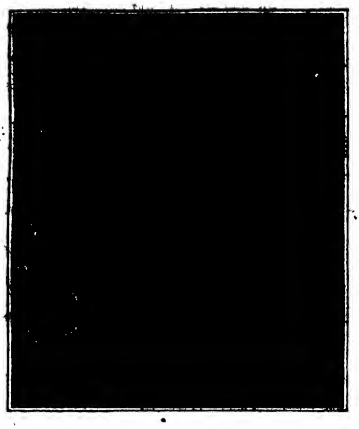

FIG. 1. CYCLONE DIAGRAM FOR NE. MONSOON.

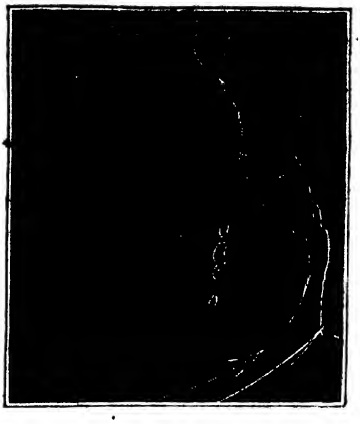

FIG. 2. CYCLONE DIAGRAM FOR SW. MONSOON.

The slight degree to which the Barometer at Calcutta and other places in Bengal was affected, up to the evening of the 4th, has been noticed by many observers as anomalous. We can only suggest, as a possible explanation of this, that the diminution of barometric pressure which determined the original formation of the Cyclone, was comparatively local, and in a distant part of the Bay. The great fall of the Barometer during the passage of the storm, was, we infer, due to the formation of the vortex, and consequent ascending current. This latter was urged forward by the strength of the southerly current, as we believe, exclusively, and it was not therefore until it approached Bengal that the Barometer there was greatly affected. Most storms that pass over Bengal are generated in the northern part of the Bay, and the local and original barometric depression is therefore more likely to be felt in Bengal, than in such cases as the present.*

Finally, to sum up in a concise and practical form the facts and views we have put forward in the foregoing pages; and first with regard to the periodicity and place of Cyclones;

I.—We find that Cyclones occur chiefly at the periods of changing monsoon.

* The only storms recorded by Mr. Piddington, the tracks of which resemble that of the storm of October 1864, are those of May 1823, and April—May 1840. Of the former we have no details, and, in the latter case the Barometer observations of Balasore, (the only place on land near the track of the storm at which the Barometer was recorded,) do not extend to an earlier day than the 29th April, the Cyclone having commenced on the 27th.

II.—That they are more numerous at the close of the south-west monsoon [October, November] than at its beginning [May, June].

III.—That they sometimes, but rarely, occur in the north of the Bay and Bengal during the south-west monsoon months [July, August, September]; never in the south.

IV.—That they sometimes, but rarely, occur in the extreme south of the Bay and between Ceylon and north latitude 5° in the north-east monsoon months, [December, January, March]; never in the north of the Bay.

V.—That at the change of north-east to south-west monsoon they occur most frequently in April in the south of the Bay; in May about equally in all parts of the Bay; in June chiefly [or only ?] in the north of the Bay.

VI.—That at the change of south-west to north-east monsoon the October storms are most frequent in the north of the Bay. In November they are rare in the north, common in the south of the Bay.

Secondly, with regard to tracks.

VII.—Storms originating in the north of the Bay usually travel between north by west and north-west by west.

VIII.—Storms originating near the Andaman Islands, (excluding those of the Andaman sea,) travel between north north-west and west.

IX.—Those originating in the south of the Bay travel usually to west, or a little to north of west.

The above may be considered as little more than an analytical statement of the facts collected by the late Mr. Piddington, with a few additions which subsequent experience has enabled us to make. They are not to be accepted as other than provisional laws, true indeed for the present data, but possibly subject to exception on longer experience. The possibility of such exceptions can only be appreciated when we are more fully acquainted with the casual laws of Cyclones. On this head we put forward the following *suggestions* as a guide to further enquiry.

I.—That Cyclones in the Bay are preceded by a strong damp stormy wind from south-west, or west south-west or west, to the south-west of their place of origin.

II.—That over that part of the Bay at which they originate, and prior to their formation, the Barometer ranges lower than usual, and lower than on the coasts around the Bay.

III.—That this depression takes place during a slight general fall of the Barometer over the Bay, such as occurs normally, at intervals of from a few days to a fortnight, at all seasons of the year: in other words, during the passage of the trough of an ordinary barometric wave.

IV.—That a general recurvature of the southerly current around the place of low barometer precedes the formation of a cyclonic vortex.

V.—That on the formation of the vortex the Barometer falls still lower over the vortex, and continues so to fall while the Cyclone gathers strength.

VI.—That the recurved south-westerly current being the chief feeder of the Cyclone, and the vortex being formed more or less towards its western limit, the weather to the east and north-east of a Cyclone is more stormy than to the west and north-west of it.

VII.—That in and around the cyclonic vortex there is a strong indraught of the wind currents, so that their direction is spiral, not circular, but more nearly circular within 10 or 15 miles of the centre than at greater distances from it.

VIII.—That Cyclones do not in all cases (perhaps in any?) move forward steadily on their track, but one vortex may break up while another is forming at some distance in advance. The duration of a central calm cannot, therefore, (even if its diameter be known,) be taken as a measure of the rate of progress of the storm, (the successive vortices being considered as one storm.)

We wish it to be clearly understood that the above are put forward as probabilities only, as *tentative and not ascertained* laws. They are inferred from data quite insufficient to establish them, but sufficient to suggest them as useful to give a definite direction to the course of future enquiry. We should not advance them at all at this stage, were it not that it is uncertain whether we ourselves may be able to proceed much further in this line of investigation, amid our other duties; and there are very many whose opportunities fit them much better than ourselves for observing facts, and verifying such generalizations as our labours have suggested to us.

The terrible devastation of the Cyclone, of which these pages are the record, followed in the brief space of one month by that of the scarcely less destructive storm of Masulipatam,* has at least had one good result. It has drawn attention forcibly to the importance of meteorological investigation, and although not the cause of the establishment of the present system of meteorological telegraphy and observation by the Government of Bengal, it has undoubtedly had the effect of causing the public to take a more vivid interest in the progress of this work, and in the study of meteorological laws. As one of the main objects of a meteorological telegraphic system is to warn the coasts and larger cities of the approach of violent storms, we will, in conclusion, point out what indications may be looked for, (assuming the correctness of the propositions enunciated above,) and what appears to us to be the best arrangement of observing stations with a view to investigating the laws of Cyclones, and warning the Central Office at Calcutta of impending storms.

The following remarks apply chiefly to Calcutta, but will, in most cases, hold good for Lower Bengal generally.

The daily variation of the Barometer is usually a little more than 0·1 of an inch, and rarely exceeds 0·15 inches. The hours of fall are from 9h. 30m., or 10 A. M., to 3h. 30m., or 4 P. M., and between the corresponding hours of P. M. and A. M. The Barometer rises from 3h. 30m., or 4 P. M. to 10 P. M., and from 3h. or 4h. A. M. to 10 A. M.

I.—If, during the ordinary periods of rise, the Barometer is either stationary, or falls, or if it falls more than 0·2 during the ordinary periods of fall, it is a sign of approaching bad weather; the probability is the greater, if this take place after a gradual small fall of the daily average, for several days.

II.—If the wind blow from south-east, working round to north-east with a falling Barometer, bad weather is probable, and the Barometer and the signs of the weather should be carefully watched.

III.—These signs should be especially noted at coast stations, with a view to warning places in the interior. At such stations the disturbance of the sea affords another indication of value, especially when there is a heavy surf with a light wind from the east or north-east.

* The loss of life by this storm, or rather by the storm-wave, is calculated, according to the most recent information we have received, at 33,000 souls. It occurred on the 5th November.

The following indications from distant stations may also be found of importance:—

IV.—At Ceylon a squally, damp wind from south-west or west south-west, with clouds moving rapidly in the same direction, and a falling Barometer, indicates a current which may probably produce bad weather in the Bay.

V.—When in Ceylon there are indications of a Cyclone in the neighbourhood, there is but little prospect of its reaching the northern part of the Bay, but it may not improbably be felt along the Madras coast.

VI.—If, at the Andaman Islands, or the Alguada Reef, or at any station on the Arrakan coast, after some days of light variable winds, and a low Barometer, a damp, squally south-westerly wind set in, there will probably be bad weather in the northern part of the Bay.

VII.—If, after a steady and considerable fall of the Barometer, conditions (IV, VI) being fulfilled, a northerly wind sets in at the stations down the west coast of the Bay, a cyclonic vortex is probably formed. And if condition I is also fulfilled, it is probably approaching, and at no great distance.

These indications should be especially noted at the periods of changing monsoon. The suggested laws of place and track should be considered in connection with the above.

From the above it will be apparent that it is of great importance to have Meteorological Telegraph Stations in Ceylon and along both coasts; if possible as far down as Port Blair on the east of the Bay. Stations in north-eastern Bengal will also be useful for indicating the prevalence of a north-easterly wind, which, as we have seen, prevailed in that quarter previous to the Cyclone of 1864.

There are many meteorological changes and phenomena in addition to those above given, which are of great value as data for forecasting weather, as has been shown by Admiral Fitzroy. Such are, for instance, the movements and character of the clouds, the moisture of the atmosphere, and changes in temperature* (if observed with great care and

* In order that Thermometric observations may be of value, very great care must be exercised in selecting a place for the instruments, so that the temperature of the air may be ascertained, not that of surrounding bodies. The best mode of placing them is in the middle of a large room in a lower story of a pucka-built house, with open windows all round except opposite to the places of rising and setting sun. When this cannot be obtained, a well thatched structure with latticed or venetianed sides built on an open site.

precaution). But these will be found fully detailed and explained in Admiral Fitzroy's work. Our object here is to treat of the laws of local changes only.

For some years to come the most important result to be expected of Meteorological Telegraph Stations is the study of these laws by a daily comparison of meteorological observations made with proper precautions over a wide area; as wide an area as possible. Nothing of value can be attempted in forecasting, until these laws are ascertained and established by a long series of verifications.

Ship observations may be made of great utility to this end; those on wind direction and force are almost always good and reliable. But it is much to be desired that more attention be paid to the selection of good Barometers for ships, and their comparison with good standard Barometers, when in port; and no observation should be recorded unaccompanied by one of temperature. The time is doubtless fast approaching when as much care will be bestowed upon ship Barometers as upon their Chronometers. But until this is done, observations taken with the greatest care and labour, will remain (not indeed worthless) but of far less value than they might be to the elucidation of the laws of the atmosphere; because they are not susceptible of strict comparison, one with the other.

THE STORM WAVE.

The fearful loss of life which has made the Calcutta Cyclone of October and the Masulipatam Cyclone of November 1864 so sadly memorable, is due chiefly to the great sea waves, formed apparently at the vortices of these storms, and which, on reaching shallow waters, were piled up to a height greatly exceeding that of the highest spring tides, when they broke over the low lying lands at the mouths of the Hooghly and Godavery, sweeping away the villages and submerging their inhabitants with their cattle and dwellings.

These waves invariably accompany such Cyclones as reach the shallow coasts of the Bay of Bengal, and their effects have been described by Mr. Piddington in his well known and valuable work "The Sailor's Hornbook." Their formation is attributable to two causes, either of which operating alone would probably be capable of producing a great sea wave; but in what proportion they respectively contribute

towards the actual result, it is extremely difficult to determine. These are, *first*, the diminished barometric pressure at the centre of a Cyclone, which in accordance with the well known hydrostatic law, would cause a flow of water towards the storm centre, until the surface at that spot stands at such a height above the mean sea level as to compensate for the diminished pressure of the atmosphere. Thus taking the sp. gr. of Mercury as 13·537, and that of sea water at 1·027, a barometric fall of one inch at the storm centre, would cause the water at that spot to rise 13·18 inches; *second*, the convergence of violent wind currents around the vortex, which, by mere friction, must tend to pile up the water at the vortex, independently of the above.

When a wave thus formed reaches the shallows of a river delta, it becomes further piled up by friction in the same manner as the tidal wave, and in rivers such as a Hooghly, forms a bore greatly surpassing the tidal bore in height, and therefore in destructive power.

Before tracing the progress of the storm wave of the 5th October 1864, up the channel of the Hooghly and its principal feeders, it is desirable, for the information of those not acquainted with the locality, to describe briefly the character of the country around the embouchure of the Hooghly. The general form of the river channels may be seen on the maps published with this report.

It is almost unnecessary to observe that the whole of the country around the mouth of the Hooghly is a low-lying alluvial formation, the greater part of which is below the level of high spring tides. The banks of the rivers and principal creeks are therefore protected by bunds or embankments, varying in height, and following the intricacies of many of the principal creeks or khalls many miles into the interior. The largest of these protective works are those along the Hidgellee coast line (right bank), where, at the time of the Cyclone, the great dyke was in course of being elevated to a section of 15 feet in height with a base of 70 feet. This dyke commences at Deega, 11 miles to east of the mouth of the Soobunrika River, where it joins a ridge of sand-hills, which form a natural protection to the coast as far as the Soobunrika. Between the mouth of the Russoolpore River and the Soobunrika, another ridge of sand-hills runs nearly parallel to the coast past Contai, and at a maximum distance of 9 miles from the coast, thus forming a second natural ridge protecting the country to the interior; but the wide channel of the Russoolpore River opens a door to the storms

wave, and, though embanked around its principal creeks, affords access to a large area of fuel and salt lands to the rear of Contai and the second line of sand-hills.

From the Russoolpore River to the Huldee, the embankment averaged at the time of the Cyclone 10 feet in height, and thence continued of the same elevation around the projecting tongue of land forming the Pergunnah of Doroo Dummun, opposite to the first great reach of the river at Diamond Harbour. All the country so protected, including the Pergunnahs of North and South Hidgellee and Doroo Dummun, was, with the exception of the salt lands around the creeks, thickly populated and highly cultivated as rice land.

On the opposite (left) bank of the river, Saugor Island and the Sub-Division of Diamond Harbour are protected by embankments, of about 8 feet average height, from Saugor Island to Diamond Harbour. The southern part of Saugor Island and the surface of the Soonderbunds generally are abandoned to jungle, but the northern part of Saugor Island has been reclaimed, and with the whole of the country to the northward, was, at the time of the storm, thickly populated and under cultivation.

Embankments are carried up both banks of the Hooghly to within a few miles of Calcutta, also up the main channels of the Roopnarain and Damoodah, and by far the greater part of the country so protected is covered with thriving villages.

Being at the end of the rains, the greater part of the cultivated lands were covered with one or two feet or more of fresh water, which somewhat mitigated the evil effects of the inundation on the crops.

To the east of the Hooghly, several broad channels (narrower, however, than the Hooghly), such as Channel Creek, the Subtermookey, the Jumoona, and the Mutlah, afford access to the interior between the low forest covered islands of the Soonderbunds. Up these the storm wave also passed, but with diminished height and force, as they were farther from the centre of the storm.

The following description of the progress of the storm wave and the inundation is based mainly on the reports of Colonel Short and Mr. O'Flaherty for the right bank of the Hooghly; of Mr. Windle for the left bank of the river; and of Mr. Verner for the same and the

district of the 24-Pergunnahs generally. Some details are taken from other sources, which will be mentioned in the course of the narrative. Plate VII is a chart of the inundation.

The storm wave at False Point rose 5 feet above the highest spring tides according to Mr. Geary's report. It appears to have reached the mouth of the Hooghly simultaneously with, or shortly after the central calm. It struck Cowcolly Light-house, according to the Superintendent's report, (see p. 34,) about half-past 10; the slight lull, which marked the passage of the centre, having occurred a little after 10 A. M. It would be high water at 12 h. 25m. P. M., or about 2 hours later, and the tide had about 2 feet to rise. The wave rose, as measured by Mr. O'Flaherty, to 16·48 feet* above high spring tide level, and 6 feet 4 inches above the top of the embankment, sweeping over the country within, and carrying away every thing in its path.

At the embankment on the Russoolpore River, 3 miles below Cowcolly, the wave rose only 11 feet 10 inches above high spring tides; at Joonpoot, on the most exposed part of the coast, 8 miles below, 9 feet 7 inches, and at the Peechabunee Khall only a little more than 1 foot. Further to the westward it was barely above high spring tides. As the mouth of the Peechabunee Khall lies about due south of Contai, it is probable that the middle of the central calm passed immediately over this spot. The great rise in the wave was, however, to the eastward of this, and it seems probable that its increase was due to its retardation over the shallows of this part of the river. The deep water channel is along the eastern side of the estuary.

Along this part of the coast, the dykes, whenever not raised to the full height of 15 feet, were breached in many places, and the interior of the country flooded. The water did not, however, remain long on the land, as the wind changed to south-west very shortly afterwards, and forced back the water which had poured in through the breaches of the embankment and the open khalls.

The wave passed up the Russoolpore River and flooded the whole Pergunnah of Bahareemootah, and the large area of salt and fuel lands to the north-west of Contai. It also breached, in many places, the embankments along the river, topped those on the left bank throughout, and passed up the open mouth of the Mirzapore Khall and many other tidal inlets.

* Measured by the mark left on the plinth at the east entrance of the Light-house.

At Kedgeree,* 3 miles above Cowcolly, the height of the storm wave was 11 inches below that at Cowcolly, 15·9 feet above high springs, and 28·9 feet above low water mark. The *Salween* surveying vessel, was driven on shore at this point; and when the water sank, she rested on the sand close to the ruins of the Telegraph Office. The inundation was 13 feet above the land level, both as sounded from the ship, and as subsequently measured on the walls of the Assistant Post-master's bungalow. The whole of Kedgeree village and bazaar was swept away, and the Post-master and his family, with a great number of natives, drowned.

At the Gurchuckerbarea bungalow, 8 miles above Kedgeree, about 1,000 feet to the interior of the dyke, the wave swept 9 feet above the level of the ground, and at Osmanchuck, about 1½ miles distant, it rose on the embankment 12 feet above the land level. The large thriving village of Gurchuckerbarea was entirely swept away, as indeed were nearly all the villages of Pergunnah Goomgurh.

At the mouth of the Huldee River, the height of the wave was 10 feet above spring tides, and diminished to spring tide level about 20 miles up the channel. "The wave topped the Huldee line of embankments throughout several feet, along some 18 miles, and the destruction of life and property near the mouth in Pergunnah Goomgurh was excessive."

North of the Huldee is the Pergunnah of Doroo Dummun, the position of which (that of a projecting reach) opposite to Diamond Harbour, together with its low elevation, especially exposed it to the destructive on-rush of the storm wave. Its eastern face bore the full brunt of the south-east and south gale, and it was when the wind was in this its most violent quarter, that the wave broke upon its low and imperfectly protected shore. The destruction of life and property which ensued were very great. These will, however, be noticed in another place.

It was low water at Middle Point, opposite to the mouth of the Huldee, at 8h. 21m. A, M., and at Diamond Harbour at 9h. 15m. A. M.; the times of high water at these places would be 1h. 13m. and 1h. 50m. espectively. The storm wave reached the latter place, according to nformation subsequently collected by Colonel Short, at 11h. 30m.; as

* This information is partly taken from the report of Captain Laycock in command of the *Salween*.

reported by Captain Lewis, (p. 35,) at 11 A. M., and therefore at 2¼ or 1¾ hours of the flood, according as we accept the former or latter. At Middle Point the height of the storm wave was 12·34 feet, and at Diamond Harbour 11·90 feet above high spring tide level, but as the land of Doroo Dummun is below this level, and the embankments average 10 feet, the storm wave swept over them everywhere, and also made its way up the numerous open khalls intersecting the line of embankment, flooding the country to a depth of 10 feet.

The chief action of the wave was against the south-east coast of the Pergunnah, *i. e.*, to the south of Diamond Harbour; on the north-east face the destruction of the embankment was less.

The Mysaudal Estate lies to the west of Doroo Dummun, between the Huldee and Roopnarain Rivers, from both of which and from the Hooghly below Kookrahatty the storm wave rolled up over the embankments; also up the numerous open khalls, flooding the country, but to a less depth than Doroo Dummun, and consequently committing less destruction.

At the border of the Pergunnah at Baliaghatta, 6 miles above the mouth of the Huldee, the height of the wave was 10 feet above the land level to the exterior of the embankment,* which it topped to a height of 4 or 5 feet, up as far as the Banka Khall. Beyond this it gradually decreased in level, and at 7½ miles further up it merely washed the foot of the exterior slope.

The inundation from the Hooghly and Roopnarain was equally, if not more severe. The wave reached Kookrahatty at the mouth of the latter river a little after 11 A. M.,† the flood tide having set in an hour earlier. It rose 8 feet above the level of the land to the exterior of the embankment, or 11·90 feet above high spring tide level, and maintained this height up to the mouth and along the narrow neck of the Roopnarain, beyond which it decreased 1 foot, which Colonel Short accounts for by a large volume having passed up the Hooghly to the north, and by the spread of the inundation over Lower Mundleghat, (between the Hooghly and Roopnarain,) as also by the widening of the channel of the latter river. "The violence of the wave may be realized when

* These embankments had been raised to an uniform height of 6 feet in 1856-57.

† These facts are taken in part from the report apparently of Baboo Deenonauth Bhuttacharjea to the Magistrate of Midnapore. The Baboo had taken refuge in the Office at Gazeepore, about 3 miles from Kookrahatty.

it is stated that at the mouth of the Roopnarain, it struck the pucca (brick and mortar) toll house of the East India Irrigation and Canal Company, situated outside the Government embankment, swept through the building, and scooped out and carried away the terraced floor."

The small Pergunnah of Cassimnuggur, at the north-east corner of Mysaudal Pergunnah, and immediately west of Doroo Dummun, "was first submerged by the wave which swept through Doroo, and then by the waters which entered the Tetoolberiah Khall. The land level is very low," and the destruction was consequently very great. "Pergunnah Mysaudal was swept by the sea from the Huldee, and submerged before the wave from the Hooghly and Roopnarain inundated it from the north; indeed the wave [from the north,] as it passed through the open khalls and topped the embankments, tended only to increase the level of the waters to the interior." At Gazeepore [see foot note of the previous page] the water in the fields began rising a little after 11, and rose to between 6 and 7 feet on the land by half-past 12 o'clock. The wind was then blowing due east. At 3 the land waters began to subside. About 7 P. M. the ears of paddy began to appear, so that the water had subsided 3 feet. At 8 A. M. of the 6th, there was 6 inches of water around the village, but it had all flowed away by morning of the 7th.

Pergunnah Terooparah is situated on the north of the River Huldee, and west of Mysaudal and the Banka Canal. The wave submerged the grazing grounds 6 or 8 feet, but the destruction of human life was less than to the eastward. The wave expended itself on Pergunnah Gomaie, next to the westward, also on the Huldee, and lying between that river and the Pergunnah of Tumlook.

From the Banka Canal up the bank of the Roopnarain to Koila Ghat, a distance of 22 miles, a series of levels taken by Assistant Engineer Ramessur Nauth shows the variations in the height of the storm wave above high spring tides, and also above the land levels inside and outside the embankment, at intervals of 440 feet. The maximum and minimum of these variations in the river channel are given on the map, as far as the scale of the latter will admit of. At the mouth of the Banka Khall the height was 9 feet 8 inches above spring tides. At Pertabkhallee it was 12 feet 6 inches; and a little below Gungakhallee, where the river channel is narrow, 14 feet 2 inches. Beyond this it decreased rapidly, till at Noonnan it was only 5 feet 2 inches;

and after another rise to 10 feet at Bampoon, it fell to 5 feet 6 inches at Koila Ghat. These maxima and minima with the corresponding levels above the land surface within and without the embankment, are shown in the following Table. Also the heights of the storm wave above sea-level :—

Locality.	Height of Storm wave in feet above			
	Spring tide level.	Mean Sea level.	Land level.	
			Outside dyke.	Inside dyke.
Mouth of Banka Khall	9·63	16·49	13·20	9·30
Below Bholsorah ...	11·95	19·55	12·00	14 40
Between Bholsorah and Doncepore ...	7 73	16·08	7·85	8·78
Pertabkhallee ...	12·53	20·23	12·28	14·40
Tumlook ...	10·44	20·77	12·81	14·52
Below Gungakhallee	14·22	21·45	14·36	17·18
Noonnan ...	5·17	13·88	8·52	8·53
Bampoon ..	10·05	18·55	11·12	12·91
Koila Ghat ...	5·51	14·51	6·65	7·76

Above Koila Ghat the effects of the storm wave were not much felt, and at the mouth of the River Doorbachutty, its height was about equal to that of the highest freshes recorded.

The storm wave reached Tumlook about a quarter of an hour before the central calm between half-past 11 and noon according to Mr. Haughton's report; after 12, according to Colonel Short, who quotes Baboo Ramessur Nauth. The wind was at the time about east. The water poured in volume over the embankment, which it topped to a depth of 8·68 feet, sweeping away a row of pucca houses inside, and scooping out the foundations. At exposed points, the first intimation the people had of the inundation was by their being carried away bodily by the

wave. At Tumlook Mr. Haughton states that the water stood 13 feet deep over the low lands around the town after the wave had passed, and continued rising till noon. Its greatest depth, as measured by the Assistant Engineer, was 12 feet over the metalled road. The town of Tumlook is built on high ground, and suffered but little by the wave, but the destruction by the wind was very great. Out of 1,400 houses 27 only remained standing.

The land of the Pergunnah of Tumlook is low, with the exception of an elevated tract on which the town is built, and which extends 1½ miles into the interior, *viz.*, up to the Pyratongee Khall. The country was covered at the time of the storm with a foot or more of fresh water, and the storm wave poured over the embankments and up the numerous open khalls, driven before the easterly gale, and submerged the country to a depth of from 8 to 17 feet. The destruction of life, cattle, and property was very great; but as, after the passage of the calm, the gale set in from the westward, speedily driving back the water into the river channel, the crops were comparatively but little injured.

To the north of Pergunnah Tumlook is that of Upper Mundleghat. Here, as in Tumlook, the "easterly gale drove the storm wave almost at right angles to the line of protective works, the waters topping them freely, and entering in volume up the numerous open drainage channels, submerging the country for several hours until the tide ebbed, when the fury of the south-west gale swept out the waters, draining the country into the Roopnarain."

The approach of the wave at Koila Ghat is described by Mr. J. P. Grant (see ante p. 38), and from his account it appears to have reached him about half-past 12, after which it continued rising, until at 10 minutes to 1 it stood about 3 feet (up to his waist) on the part of the road on which Mr. Grant stood. This was on the eastern bank of the river. On the western bank, as noted above, the water stood 7·76 feet above the land level to the interior of the embankment, and Colonel Short mentions that the metalled road was submerged 3½ feet. At Panchoogunj, 5 miles above, the wave barely topped the crest of the embankment, and at the mouth of the Doorbachutty River, 1 mile farther, "the wave may be said to have expended itself."

"The wave entered the Koila Khall in volume, sweeping up parallel to the metalled road, and topping it freely several miles up and to beyond Doolah. It entered Pergunnah Cassijorah (to the west of

Upper Mundleghat), the level of which is so low, that special channels are periodically excavated with the view of draining the country. The lands were at the time 1 or 2 feet under water from local rain, and the level was considerably raised by the ingress of the inundation through so many channels. The crops were submerged for an hour or two, until the waters were driven into the Roopnarain by the south-west gale. Whilst the water mark was 3½ feet above the level of the road at the Koila bazaar, it was 6 inches above the road surface at Dooleah, 2½ miles westward; the average depth of the nundation above the level of the country must, therefore, have been temporarily about 6 to 8 feet. The height of the inundation decreased gradually to the interior, along the road at Dordabar, Dealbar, and Tendah, ... and the inundation did not extend beyond Siddha; but the action of the gale on the waters held up to the interior caused them to top and damage the metalled road at Mezgaon and Bolshur."

From the foregoing it appears that to the west of the Roopnarain, the inundation extended for an average distance of 9 or 10 miles. Below the mouth of the Roopnarain, the inundation was more extensive and generally more severe, as the waters from the estuary of the Hooghly swept over the low lying promontory of Doroo Dummun and Mysaudal, and up the wide channels of the Huldee and Russoolpore Rivers. We shall now return to the mouth of the Hooghly at Saugor Point, and note the progress of the storm wave up the east bank of the river, and over the Diamond Harbour Division of the 24-Pergunnahs. Also up the Hooghly channel above its junction with the Roopnarain, and over the country lying between these two rivers.

At Saugor Point the wave was probably not much, if at all, above high spring tide level, inasmuch as, at the mouth of the Peechabunee Khall almost exactly opposite, it was only 1 foot 1 inch above that level, and Saugor Point is 9 miles to the eastward. In any case the wave did not top the embankments at this point, and the Telegraph and Light-house Station escaped the effects of the wave. Over the northern part of the island, however, the wave swept in volume 10 to 11 feet over the land, sweeping everything before it. At Mud Point, at the northern extremity of the island, the water line was measured 11 feet above the ground surface. The northern end of Saugor Island was cut in two by a new channel, about 1¾ miles below the station at Mud Point. This was probably formed by the outflow of the flood waters. On the Soonderbunds to the eastward, the wave was 10 feet above the ground level.

The storm wave broke over the southern portion of the Sooltanpoor Thannah (north of Saugor Island) at 11 o'clock,* and rapidly inundated the country within 10 miles of the Hooghly. The recorded height of the crest at Middle Point below Rungafullah is 12·34 above high spring tides.† At Rungafullah it was measured by marks in the village, 20 feet 3 inches above the level of the rice-fields.‡ Mr. Verner reports, on the information collected from the inhabitants, &c., that at Shikarpore and Moreegunge in the extreme south of the Sooltanpoor Thannah, the height was as much as 30 feet, but this is probably excessive, as the height at Rungafullah quoted by him is also overestimated by nearly 4 feet. At Tingree Biggee,‡ 1 mile above Rungafullah, the water overflowed the country close to the river bank, to a depth of 14 or 15 feet, and is reported to have reached about 8 miles inland. At Culpee,‡ its depth was measured 7·13 feet above the bund and 13 feet above the ground, and at Dynanpoor, Sooltanpoor, and other villages about 5 miles east of Culpee, it was estimated at 7½ feet by Mr. Verner. The water poured over the country about three hours, and then began to abate. Many of the villages were swept away entirely, and the destruction of life and property were very great, especially around Rungafullah, where the population previous to the storm had been very dense. In this part the crops were totally destroyed.

The approach of the storm wave at Diamond Harbour is described by Captain Lewis (commanding the Hospital Ship *Bentinck* at that station), and also by the Assistant at the Telegraph Office. The former account has been given at page 35§; the latter is as follows:—"10 h. 33 m. [?] tide approaching rapidly; signalled to Signaller through the direct line (to Calcutta) that the tide is making fast; should he not 'get us' an hour after, to conclude that we are washed off. About 11 or half-past the tide overflowed the bund and entered the Office, smashing everything in its way. At a quarter to 12, we (19 men of the Telegraph Establishment, 4 Post Office men, and 20 outsiders,) were obliged to abandon the Office for the upper story ..... 12 h. 30 m.; staircase leading to upper story washed off; after this we were compelled to go on the

* According to the information collected by Mr. Verner.

† Colonel Short's report on Doroo Dummun.

‡ From a report by Mr. J. A. Windle, Officiating Executive Engineer.

§ The time of high water has, however, been erroneously quoted at p. 36. It should be 11 h. 30m., instead of 10 h. 30 m., and therefore half an hour *after* the arrival of the storm wave. But for more correct information see p. 113.

open terrace under heavy rain, strong wind, and the spray caused by the waves dashing against the building. At about 2 P. M. ..... tide somewhat slackening. About 4 P. M. descended from the upper story by means of signal flags twisted and knotted, and ..... at 5 P. M. left Diamond Harbour Station on foot [for Calcutta]."

As measured by Mr. Windle, the height of the storm wave at Diamond Harbour was 4·58 feet over the top of the bund, and therefore (allowing 8 feet for the height of the embankment) about 12 feet 7 inches above the land level. It was (as mentioned by Mr. Verner) 3 feet above the metalled road. It may be observed that the wind being from south at the time of the arrival of the wave, the water was carried nearly at right angles against the bank. Hence the destruction was immense, and many villages were swept away with all their inhabitants. The loss of life is estimated at 75 per cent. along the river bank, and at 50 per cent. a mile inland; three miles inland, the water was over a man's height (say 6 feet). Three pucka houses and the wall of the Jail compound (enclosure) were washed down; the Magistrate's house considerably injured, the water forcing up the terraced verandah floors, and knocking down the front wall of the verandah facing the river.

The wave began to subside about 2 o'clock, according to Captain Lewis and the Electric Telegraph Assistant, in the interior about 3 or 4 P. M., according to Mr. Verner, but the country to the north of Diamond Harbour remained flooded for four or five days after.

From Diamond Harbour the wave swept over the land due north, through the middle of the Deveepoor Thannah towards Atcheepoor. This part of the country suffered more severely than that along the Hooghly bank to the westward, owing to the lower level of the land.

At Hooghly Point (Noorpoor) the storm wave is said to have come up about noon, sweeping across from Diamond Harbour, with the wind at south-east. We have no information of its depth over the land, but the destruction that ensued was very great.

Passing Hooghly Point, the wave was divided between the channels of the Roopnarain and the Hooghly, sweeping at the same time over Fort Mornington, and the low tongue of land that divides the two rivers forming the Pergunnah of Lower Mundleghat. The details of the depth of the inundation on this Pergunnah are given on Plate VII. In a map received from the Commissioner of Burdwan, this portion is colored as having been subject to equal destruction with Doroo Dummun and

Kedgeree. It was 15 feet along the bank of the Hooghly, and averaged from 6 to 8 feet in the interior. The Magistrate's report confirms this. It states 'the position of these parts of the country rendered them specially liable to danger from such a flood as rushed up the Hooghly on the day of the storm, and they suffered accordingly. The embankments, sufficient to protect the country at ordinary times, were on this occasion utterly useless; they were overtopped, breached, and more or less destroyed, and the country then lay at the mercy of the flood. It was devastated, but its destruction was in all probability the salvation of Calcutta.'

The storm-wave poured up the Damoodah and flooded the country on both banks to some distance beyond Moishraka Ghat on the Midnapore road. The tongue of land between the Damoodah and Hooghly was flooded from both rivers, and here also the destruction very severe. Mr. R. W. King, the District Superintendent of Police, writes:—"In the villages on the river side, and more particularly those which lie to the south of Oolabariah, the loss of life has been very heavy. It appears from what I gathered from the survivors, that the deluge came upon them almost instantaneously, not by any gradual rising of the tide; consequently the women and children had no time to escape, but were drowned in their houses." At Koosberriah (a village near Oolabariah) 'after the Cyclone had commenced, the women and children and many of the men took refuge within their houses. Almost in an instant, and without any warning, the water was over the village, and just about the same time the heaviest gusts of wind came, which threw down all the huts, so that the inmates, even if they were not actually drowned, could not escape. To crown all, a number of large peepul and other trees were blown down on the *debris* of the houses. This, of course, completed the destruction of man and beast. The whole is now (2nd November) one festering mass. I attempted to go near it, but the fearful stench rendered it impossible for any one to do so. The only course to follow with this and other villages similarly circumstanced, will be to leave them until the dry weather, and then to fire the whole mass.' Mr. Bayley of the Electric Telegraph Department states in a letter to Colonel Douglas, that at Oolabariah the water stood 6 feet deep over the floor of the Dâk Bungalow, (the only house left standing.) This would be not less than 8 feet over the land level.

At Atcheepoor on the opposite (left) bank of the Hooghly, a little below Oolabariah, the depth of the inundation was 3·97 feet over the

land, but the wave which topped the bund (here 4·31 feet high) was 2·18 feet higher. The wave came up two hours in advance of the flood tide, and the water subsided at 6 P. M. There was considerable loss of life about Atcheepoor, but the destruction was less severe than on the right bank of the river, and less also than further inland about Deveepoor and to the west of the Diamond Harbour road, where the land level is low.

The flood extended to the eastward as far as Bankeepore, where the water stood about 1 foot above its usual level. No rush of water was however felt, and the damage was but slight. So also beyond Atcheepoor to the north, the flood was felt, and both banks of the river submerged, but few lives were lost. At the Botanic Gardens (on the right bank) below Calcutta, the flood extended only about half a mile inland, over the greater part of the garden, to a depth, in some places, of 6 or 7 feet. "The storm-wave rushed over the garden like a torrent, sweeping away the gravel* from all the roads at a right angle to its course, and strewing it over the lawn and on the flower beds. The road on the river embankment was almost entirely destroyed."*

The storm-wave reached Calcutta at 3 h. 45 m. P. M., an hour after the maximum violence of the storm, and when the wind was about from the south-south-west. It would have been high water at 4 h. 37 m., so that the wave was nearly 1 hour in advance of the tide. The water stood at 23½ feet above the sill of Kidderpore Dock. This is about 5 feet higher than the high water mark of the day, and about 6 inches absolute height above that of the wave at Atcheepoor. The water submerged the low lying tract about Garden Reach, and a considerable portion of the Maidan,† being about 3 feet deep over the Strand road. It lifted the ships at their moorings, breaking the hawsers and chains, already strained to the utmost by the sheer force of the gale, and the whole shipping of the port, thus set free, drove in masses before the wind on to the shoals and river bank of Seebpore and Cossipore.

The wave swept up the river far beyond Calcutta, flooding the banks in many places, but not to such depth as to endanger life. It appears from the following extract of a report by the Assistant Magistrate of Mehurpore, to have been felt as a distinct wave far up the Matabangha:—"During the latter part of the storm the rivers rose suddenly and topped their

* Report of the Superintendent, Dr. T. Anderson.

† The plain in the centre of which stands Fort William, and around which Calcutta is built.

banks, leaving large fish and river scum at a considerable distance inland. A Native, too, who had a narrow escape, states in confirmation, that he felt his boat suddenly uplifted and wrenched from her moorings, and cast violently against the bank of the River Matabangha."

It only remains now to notice the effects of the wave on those subdivisions to the south-east of Calcutta which were more or less flooded from the Soonderbund rivers to the east of the Hooghly. In these the destruction was far less severe than in the Pergunnahs lying along the Hooghly and Roopnarain, owing partly, as we have already pointed out, to their greater distance from the storm centre, partly to the more inland position of the cultivated tracts.

In the Baracepore Thannah of the sub-division of the same name, those parts to the eastward, around the Piallee River, suffered severely by inundation. A few villages were submerged, but the loss of life amounted to five persons only. The inundation occurred about 3 P. M., but the water did not remain long on the land, and by 8 P. M., that on the paddy fields had subsided, as a general rule, nearly to its usual depth in the rainy season.

In the Joynugger Thannah to the south of Baracepore, the eastern and south-eastern parts chiefly suffered, but not severely. The inundation was chiefly that of fresh water; "the saltish water, which overflowed the Soonderbund lots to the south and south-east, appears to have overflowed the Government bunds, and to have forced the fresh water overlying the paddy, before it, and to have thus caused the country around to be flooded with water but very slightly saltish. The Culpee road, which passes through the village of Muzillpoor, stood a foot under water in many places, and the low lands remained flooded for a week after the Cyclone." The Soonderbund lots to the south and south-east suffered more, being inundated by the waters of the Piallee, Teekuronee, and Monee, and a large number of cattle were destroyed. The loss of human life only amounted, however, to seven persons. The water rose at 3 P. M. to a height of 5 feet, and passed on in a steady current. A few hours after the storm was over, it had almost disappeared.

On the Mutlah, the town of Port Canning and nearly the whole of the Thannah of Mutlah were inundated, and the tanks of Port Canning filled with salt water. No loss of life was reported.

From the above, it appears that the total cultivated and inhabited area inundated by the storm-wave was about 1,500 square miles. Over more than half of this, the water was 6 feet deep and upwards, and in a few places, Kedgeree, Doroo Dummun, Rungafullah, &c., as much as double and even treble this depth.

In the Hooghly, the greatest height of the wave recorded was 16 feet 6 inches above high spring tide level, and 26 feet 9 inches above mean sea level. This was at Cowcolly. From this point the height diminished gradually to Diamond Harbour, where the wave was 11 feet 11 inches above high spring tide, and about 22 feet above mean sea level, while at Middle Point, intermediate between the two places, it was 12 feet 4 inches above high springs and 24 feet above mean sea level. In the Roopnarain its height was very variable, owing, probably, to the variations in the channel; its greatest height (below Gungakhallee) being 14 feet 2 inches above high spring tide, and 21 feet 6 inches above mean sea level, while at Noonnan, only a few miles beyond, it was but 5 feet 2 inches above spring tide, and 13 feet 10 inches above mean sea level. At Calcutta it was about the same height as the highest spring tides, and 14 feet 5 inches above mean sea level. It was felt as a wave as high up as Mehurpore on the Matabangha.

The doubt which attaches to the reported hours of the arrival of the storm-wave at various points, does not allow of our calculating its varying rate of progress with any confidence. It struck Cowcolly at half-past 10, and reached Calcutta at 3-45, having, therefore, taken $5\frac{1}{4}$ hours to traverse the intermediate distance of $82\frac{2}{3}$ miles, equal to a rate of $15\frac{1}{2}$ miles an hour. This appears anomalous, as the crest of the tidal wave occupies but $3\frac{1}{2}$ hours in traversing the same distance, and we should have inferred from the greater height of the storm-wave, that in accordance with the laws of the wave of translation, its rate of progress would be in proportion to its height.

DESTRUCTION OF LIFE AND PROPERTY BY THE STORM, STORM-WAVE, &c.

This part of our report has been to a certain extent anticipated by that drawn up by the Secretary to the Government of Bengal about three months after the occurrence of the Cyclone. In the period of upwards of a twelve month that has since elapsed, materials have however accrued for a more complete estimate of the loss of life and property, than was possible at the date of Mr. Eden's narrative, and it will therefore not be superfluous to append to our discussion of the physical phenomena of the storm and storm-wave, an abstract account of their social and economic effects, as now ascertained.

It must not indeed be expected that our statistics even now accurately represent the truth. Destruction so wholesale as that which overwhelmed Doroo Dummun, Goomghur and Diamond Harbour must, for a time, disorganise the social machinery for collecting such data, even when more systematic and perfect than any that is possible among the agricultural population of India; and in India, at the very best, such statistics can never be regarded as other than an approximation to truth. Moreover, as has been pointed out by Mr. Montresor, the loss of life could only be estimated by the number of persons missing, and it is very probable that many of those so reported had escaped destruction, and had left for other parts of the country where food and assistance were procurable, in the interval between the catastrophe and the time when a rough census could be taken of the survivors. On the other hand there was much loss of life by the foundering of boats on the great river system up which the storm swept in all its fury, and which has never been reported, owing to the victims being strangers from other parts of the country; and for several Pergunnahs of the Midnapore District, where the storm-wave undoubtedly caused great loss of life, no returns whatever have reached us.

The uncertainty that attaches to any estimate of the loss of human life, inheres to a still greater degree to that of cattle and property destroyed, with the exception of Government property, of which trustworthy returns have been drawn up by the Civil Officers, and the Department of Public Works. The loss of cattle as estimated, is probably over rather than under the truth; for in such cases the villagers

are scarcely likely to understate their loss, even apart from that tendency to exaggeration which more or less vitiates all accounts of great catastrophes, not drawn up by trained and cautious observers.

Of the loss of other kinds of private property than cattle and crops, and in part of the shipping, we are not aware that any such estimate has been formed. Indeed any such estimate is scarcely practicable, as those who alone could have given the required information in the districts that suffered most, perished in the flood, and elsewhere, even if obtained, they could not be considered reliable.

A.—LIFE.

The chief loss of life on the 6th October was that caused by the storm-wave. The deaths by the storm were not very numerous, with the exception perhaps of boatmen and others in the river, but even these last bear no proportion to the numbers who were swept away and drowned by the rush of the flood. But in some districts, notably in Midnapore, the immediate losses were equalled if not outnumbered by the deaths caused by the famine and pestilence, (cholera, dysentery and small pox,) which were in a great measure the consequence of the inundation. The prompt measures taken by the Calcutta public, by Government and its local Officers, and by many private persons, to send supplies of food and clothing to the districts that had suffered most severely, alleviated the pressure of famine after the lapse of a few days. But the putrid vegetation and unburied bodies and carcases which for many weeks lay strewn over the country,* the consumption of bad food, and impure water, were evils less readily to be dealt with, and these fertile causes of disease, acting on a people already under severe mental prostration from the loss of their relations and property, proved more fatal than even the deluge which had primarily overwhelmed them.† Thus in Pergunnah

* It is lamentable to note that the prejudices of the agricultural classes to touch a dead body were proof even against the imperative dictates of self preservation. The predacious animals, jackals, vultures, &c., had been destroyed in the storm, and bodies lay strewn over the country for many weeks after the Cyclone.

† Of the dreadful mortality in the month of November and December, there is ample evidence; but this is not to be attributed entirely to the effects of the Cyclone, although it was much aggravated thereby. Mr. Montresor reports that "almost entire villages have been depopulated from those awful scourges, cholera and small pox," and Mr. P. Dickens, in a letter dated the 11th December, states that "sickness is fearfully on the increase. Cholera is spreading and has attacked almost every village. Five or six persons died here last night, and in one small village, I visited containing a population of 150, forty deaths were reported." Again, on the 13th December, "I find the people exceedingly apathetic in applying for relief; this I attribute chiefly to the lamentable amount of sickness." The

Gomai 23 persons only are recorded as drowned, while not less than 526 perished by subsequent sickness. In Teraparah 132 were drowned, and the deaths by sickness are reported at 515. In Mysaudal the loss by the storm-wave was 3,740, but that by sickness amounted to not less than 4,243. In Cassimnugger, on the other hand, the reported losses by drowning exceed those by sickness, the former being 686, the latter 496. In most districts the returns appear to have been drawn up at too early a period to allow of the loss by pestilence being fully ascertained. This and the possible emigration previously noticed, render it somewhat difficult to estimate the comparative loss of life from various causes.

Our sources of information for the following details are the reports of the Commissioners, Magistrates and Assistants, and Police Officers of the different divisions and districts; Colonel Short's reports on the effects of the storm-wave in the districts to the west of the Hooghly; Mr. Verner's special report on the 24-Pergunnahs, and Captain Burbank's on the loss of the 'Ally' and the destruction of the cooly depôts. These are all official reports, and may therefore be accepted as trustworthy within such limits as circumstances have allowed of. Colonel Short's reports are of later date than those of the Commissioner and Magistrate for the same area, so that the greater loss of life reported by the former may be explained by the ravages of cholera, &c., which set in about a month after the Cyclone. But other discrepancies do not admit of such an explanation. In such cases we shall assume that of latest date to be the more correct, when the character of the returns does not admit of a more satisfactory mode of choice.

Midnapore District.

Southern Hidgellee.—For this sub-division we have no returns of the loss of life. Only the northern part, *viz.*, the Pergunnahs to the south of the Russoolpoor River, was deeply flooded by the storm-wave, and much of the land submerged was uncultivated, being the salt and

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Superintendent of Cowcolly Light-house, in a letter dated 7th December, states that "the unfortunate inhabitants are dying in scores every day, from a disease very similar to cholera, brought on by using the water of this place. Every tank, pond and well is stagnant with decaying matter, both animal and vegetable, besides being filled with salt water. I cannot accurately state what the loss of life has been by the Cyclone and inundation, but I am afraid the fatal malady has carried off more. There is utter desolation everywhere. Scarcely a human being to be seen The paddy, now ripe, is left in the fields for the cattle to destroy. When I have asked any of them the reason of this, the answer always was, "who is to eat it?"

fuel lands lying outside the protective works. Nevertheless the loss must have been great. Colonel Short writes,—"The fury of the Cyclone caused a fearful destruction of the villages to the interior; indeed the raised plateaux, on which many stood, were swept clean, and the consequent misery must have been great. It appears that the people believing the lull in the storm [the passage of the central calm] to be the sign of its having passed over, proceeded to bring in their cattle, and whilst so engaged they were overtaken by the waters, which, topping the lowest parts of the dyke or entering through the breaches, drowned man and beast; while many standing on the high ridges separating the fields, were, during the height of the Cyclone, literally swept into the water and drowned." A small isolated circuit of embankment bordering on the Russoolpoor River encloses about half a square mile of cultivated land in the midst of the salt lands to the rear of the second line of sand hills. Over this the wave swept unimpeded, and "all within the circuit, including cattle, must have been carried away, surrounded as they were by a sea breaking 6 to 8 feet high over the land, and lashed by the Cyclone." In Bahareemootah to the exterior of the embankment, the destruction was very great over an area of 56 square miles, and greater than inside the embankment, as the villages are larger, more numerous and better populated. To the west of the Peechabunnee Khall the loss of life was comparatively trifling, but the violence of the storm caused great destruction in the villages, and many cattle must have been drowned, as evidenced by the numerous skeletons heaped together at certain localities along the dyke.

Whatever was the loss by the immediate effects of the storm, it was, Colonel Short opines, "equalled by the terrible amount of sickness consequent upon the visitation, owing to the absence of shelter after the storm, at a season when it was most required, the want of good water owing to the ingress of salt water into many of the tanks, and the fouling of the water in others, owing to the fallen trees and the debris of villages. The desolation and misery, however, were mitigated by the country being at the time several feet under rain-water, held up within the protective works, and the prompt action taken by the Cyclone Relief Committee in transmitting food and clothing to the panic-stricken population, as also by the prompt assistance afforded by the Government in detaching medical aid to meet the requirements throughout the area visited."*

* These quotations are taken from a report on Southern Hidgellee, by Colonel Short, drawn up several months after the catastrophe.

NORTHERN HIDGELLEE.—This portion of the Midnapore district suffered more severely than any other, with the exception of Doroo Dummun and Mysaudul to the north, inundated, as it was, from three sides, and swept by the full fury of the gale. Nowhere was the destruction greater than in the small Pergunnahs of Kusba Hidgellee and Par Bissian, which form the point of land at the junction of the Russoolpoor River and the Hooghly. In Erinch Pergunnah to the north and north-west, it was only in a measure less. In these three Pergunnahs, comprising an area of 129 miles, no record of the loss of life is obtained, but Colonel Short thinks that it would be no exaggeration to admit that it was equal to that of Goomghur and Aurunganugger, or in round numbers about 14,000 souls from all causes.

"Pergunnah Goomghur, containing an area of 103 square miles, was swept along a length of about 12 miles by a continuous line of wave from the Hooghly, and a detailed statement of the losses in 109 villages shows that 8,159 individuals were drowned by the storm-wave, and 5,734 have since died owing to cholera, dysentery, fever, &c., brought on from exposure, and want of food and good water. Thus 13,893 are reported to have died since the 4th October last in one Pergunnah, the people in which were very prosperous; so much so, that no inducement could persuade them to work at the embankments."

"In Pergunnah Aurunganugger, which is situated to the west of Goomghur and on the Huldee, 106 people were drowned by the storm-wave, whilst 830 died from the effects of submersion and the pestilence which followed the visitation, and this can be credited, as the tract (20 square miles) is very low, and at all times very unhealthy."

Pergunnahs Dutcurca, Kismut Pataspore, and that part of Nurooamootah to north of the Bagda and situated to south-west of Northern Hidgellee, comprising about 42 square miles, were swept by a wave several feet in depth; but we have no returns of the loss of life. The Pergunnahs more to the interior, Jellooamootah and Soojamootah, suffered less.

The Commissioner of Burdwan reports, in a letter dated the 30th December, that the loss of life in Goomghur and Agra Chuck amounted in round numbers to 8,000 and in Aurunganugger 100; and the Assistant Superintendent of Police states on the 3rd December, that the deaths reported at the Police Station of Nundigaon (Goomghur) were 1,162 by falling of houses, &c., and 8,056 by the flood; total 9,218. These two

later reports evidently do not include the mortality by subsequent sickness, which raged in November and December. They tally, therefore, pretty closely with Colonel Short's report. The results may be summed up as follows:—

Goomghur and Aurunganugger.

	By storm and flood.	By sickness.	Total.
Colonel Short ...	8,265	6,564	14,829
Commissioner of Burdwan .	8,100	.....	.....
Assistant Superintendent of Police	9,218	.....	.....

Erinch, Kusba Hidgellee and *Par Bissian.*

Colonel Short (estimated) ...	8,000?	6,000?	14,000?

Dutcurea, Kismut Pataspore, &c.

Loss considerable. No returns.

Mr. Smith, the Magistrate of Midnapore, states that the people of Goomghur estimate their loss at three-fourths of the population.

Doroo Dummun.—For this Pergunnah, which suffered perhaps more severely than any other, the only report which pretends to rest on actual returns is that of the Assistant Superintendent of Police, Mr. Haughton. At Sootahattee 266 deaths by falling houses are reported and 5,691 by drowning, making a total of 5,957. But there appears to be little doubt that this is very far below the actual loss. The Collector of Midnapore, Mr. A. Smith, records 16,000, the Commissioner of the Burdwan Division 12,000, and Colonel Short 10,000, by the Cyclone and wave alone. Before the Cyclone, the Pergunnah contained about 258 villages and a population of about 36,000, so that the records quoted by Colonel Short show a loss of between one-third and one-fourth of the population. But the loss by subsequent sickness was also very severe, as is shown by the reports of the Commissioner, Mr. P. Dickens, Mr. Neill, and Colonel Short. Of its actual extent we have no means of forming an estimate. The level of the land is very low, and it was probably not less in proportion, than in the Pergunnahs to the south of the Huldee.

Mysaudul, Cassimnugger, Teraparah, and Gomai.—These Pergunnahs lying to the west of Doroo Dummun and between the Huldee and the Hooghly and Roopnarain, comprised 171 villages, all large and

well populated. These were nearly all swept by the storm-wave, the fatal results of which, and of the consequent sickness, are shown by the following returns quoted by Colonel Short:—

	Deaths by drowning.	By sickness.	Total.
Cassimnugger, 13 villages	686	496	1,182
Mysaudul 121 „	3,740	4,243	7,983
Teraparah 22 „	132	515	647
Gomai 15 „	23	526	549
Total ...	4,581	5,780	10,361

Mr. Montresor's returns of the loss by the storm-wave only, are the same as the above, except that they are given in round numbers; they are probably taken from the same source.

TUMLOOK.—For this Pergunnah, Colonel Short states that no definite information is obtainable of the number of lives lost, but the partial returns obtained by him give the number as 1,730 by the storm and storm-wave. Of these 30 were reported in the town of Tumlook, but the Magistrate observes that the ascertained deaths in the Municipality were 436. Mr. Haughton returns the loss at 1,946, of whom 610 were killed by falling houses, &c., and 1,336 by the flood.

The Pergunnah contains 207 villages, all of which were large and well populated, but the land is low, and the climate unhealthy. We have no information of the amount of loss by subsequent sickness.

From the above it appears that the total loss of life by the Cyclone in the Midnapore District actually reported or estimated by competent authorities is as follows:—

Goomghur	8,159	reported.
Aurunganugger	106	„
Kusba Hidgellee		
Par Bissian	8,000	estimated.
Erinch		
Carried over ...	16,265	

Brought forward ...	16,265	
Doroo Dummun . .	10,000	estimated.
Cassimnugger . .	686	reported.
Mysaudul	3,740	,,
Teraparah	132	,,
Gomai	23	,,
Tumlook	2,166	,,
Total ...	33,012	

This number is exclusive of the losses in Southern Hidgellee, and the Pergunnahs of Dutcurea, Kismut Pataspore, and Nurooamootah, which are known to have been heavy, and those in Jellooamootah and Soojamootah, which are comparatively slight. The returns for Tumlook are also imperfect.

Mr. Eden summed up the mortality of Midnapore at 20,000, but we fear that our present data must be taken to prove a much greater loss.

The deaths by sickness in the cold weather months, and which must in part be attributed to the effects of the Cyclone, may be summed up as follow:—

Goomghur	5,734	reported.
Aurunganugger	830	,,
Erinch		
Kusba Hidgellee	6,000	estimated.
Par Bissian...		
Cassimnugger	496	reported.
Mysaudul	4,243	,,
Teraparah	515	,,
Gomai	526	,,
Total ...	18,344	

to which must be added the mortality of Tumlook, Doroo Dummun, and all those Pergunnahs above enumerated, for which no Cyclone returns have reached us. On the whole, the losses by sickness appear to have been nearly, if not quite equal to those by storm and flood.

Hooghly District.

Only the southernmost Pergunnahs of this district suffered severely, viz., Upper Mundleghat and the southern half of the Howrah Police District. The returns for the Police district of Howrah show a total loss of 1,978 souls* by the storm and storm-wave, of whom 10 were in the Town and Suburbs of Howrah. Upper Mundleghat appears not to be included in this return, and for this Pergunnah we have no definite information. Mr. Smith, the Magistrate of Midnapore, writes that 62 deaths were reported at the Police Station of Panchkorah, but that this was less than the number known to have occurred at Koelah only. Colonel Short states that the loss of life by the storm-wave in Upper Mundleghat was greatest between the boundary of Tumlook and the Denan Khall; in the village of Baripore 20 people were carried away; in Gobra 208 people; and in Zameerta 50; "indeed the visitation in this part of the Pergunnah was very great, * * * * * * * whole families being found dead, all clinging to one another, while corpses of men and bodies of cattle were to be met with along the line of embankment and elsewhere." Baboo Heera Lal Seal (the Zemindar of a large tract of country in this

* These are tabulated as follows :—

		Men.	Women.	Children.	Total.
Howrah Town and Suburbs.	Seebpore	2	...	...	2
	Howrah	3	...	..	3
	Gollabary	5	...	...	5
	Bally	...	..	..	..
	Doomjoor	8	4	1	13
	Juggutbullubpore	3	2	...	5
	Amptah	17	6	9	32
	Bagnan	3	3	..	6
	Shampore	385	497	605	1,487
	Oolabariah	179	131	115	425
	Total	605	643	730	1,978

and the neighbouring Pergunnah of Lower Mundleghat) assured Colonel Short that, great as was the destruction of life from the storm-wave, the mortality consequent on the visitation was greater. We have seen, however, no general returns or even estimates of the mortality either by the storm and wave, or by consequent sickness.

The Police District of Hooghly, the northern part of the Revenue District of the same name, suffered a loss, as registered by the Police, of 112, but the Magistrate believes that many deaths have not been reported. The Thannahs which suffered most were those of Bullagore and Serampore.* An epidemic raged in this district in the cold weather months following the Cyclone, but we are not informed whether it was of a more fatal character than that which has ravaged several districts of Lower Bengal, almost annually during the last few years.

The destruction of life for Hooghly District may be summed up as follows, assuming the loss of Upper Mundleghat to be 300, which was certainly within the truth :—

Howrah	1,978
Upper Mundleghat	300
Hooghly (Police District) ...	112
Total ...	2,390

Soonderbuns and 24-Pergunnahs.

The Police returns give a total loss of 12,000 for the 24-Pergunnahs, including Saugor Island. Mr. Payne, a Missionary, who was engaged in distributing relief over this part of the country after the Cyclone, estimates that all villages within one mile of the river [from Diamond Harbour downwards?] lost 80 per cent. of their inhabitants, and that in other villages over which the storm-wave swept, the loss was from 30 to 40 per cent. Mr. Windle, whose report on the storm-wave along the left bank of the Hooghly has been largely quoted in the preceding pages, estimates that on the river bank below Diamond Harbour, the

* From the report of the Commissioner of Burdwan, Mr. Montresor.

loss of life was fully 75 per cent., and at a mile inland 50 per cent. of the population; and gives the following illustrative facts: —

"At Diamond Harbour one man from whom enquiries were made had lost 15 relations. A village adjacent to his was swept away with all its inhabitants. The village of Ramrampore, containing about 150 inhabitants, was swept away and only 40 people saved. The person who gave the information had lost his father, mother, three brothers and his wife. In the village of Kalynugger, about two furlongs inland, containing 30 houses, only 30 out of 90 people were saved.

"At Culpee, in one instance, 10 out of a family of 11 perished; and the village of Bhogwanpoor, containing 80 houses, is reported to have lost 105 of its inhabitants.

"At Tingree Biggee, the gale occurred on the Hât (fair or market) day, and three hundred, mostly shop-keepers, are supposed to have perished at the Hât. In three different families 1 out of 9, 1 out of 6, and 4 out of 10, respectively, were saved.

"At Rungafullah 4 out of 5, 2 out of 6, and 60 out of 130 were saved, showing a loss of 53 per cent.

"At Mud Point at the northern extremity of Saugor Island, but one hundred and seventy persons survived out of three hundred and fifty families = 1,500 to 1,800 souls."

The following details from Mr. Verner's and other official reports show approximately the loss of life in the different sub-divisions and thannahs of the district:—

Saugor Island.—The returns for this Island are more reliable than those from any area that suffered equal destruction. The island being of comparatively recent settlement, the population at the time of the Cyclone was known pretty accurately, and Mr. Hugh Fraser, the holder of the grant, obtained at great personal labor, accurate reports of the number that survived the catastrophe. The population previous to the Cyclone was 5,625; of these but 1,488 survived, of whom 802 only were men. The loss of life was therefore 4,137 souls, or rather more than 73 per cent.

Diamond Harbour.—Of the four Thannahs composing this subdivision, that of Sooltanpore suffered most severely; 10,759 persons*

* It would appear from the statement above quoted from Mr. Eden's report, that this number includes the loss on Saugor Island, as we have therefore assumed such to be the case. Mr. Verner's report, however, leaves it somewhat doubtful.

perished, a loss supposed to be about one-third of the whole population before the Cyclone. The cholera which raged subsequently had carried off 4,011 persons at the date of Mr. Verner's report, when its ravages were stated to be on the decrease. In the Thannah of Govindpore, 1,360 persons are ascertained to have lost their lives in the Cyclone, but Mr. Verner observes that this does not appear to represent the entire number who perished. Cholera raged subsequently, as in other parts of the storm-wave area, but there are no returns of the actual losses. In Deveepoor Thannah the total number of deaths reported were 135, the loss in the villages to the west of the Diamond Harbour road being greater than in the villages further westward and along the river above Hooghly Point. In Bankipore Thannah, 18 deaths only are reported. The total destruction, therefore, of the sub-division, is 12,272 souls.

BAROEEPORE.—This sub-division is situated to the east of Diamond Harbour, and south-east of Calcutta, and includes Port Canning, and the country through which passes the Mutlah Railway. It was inundated chiefly from the Mutlah and the channels intervening between that river and the Hooghly, but escaped the sweep of the wave which produced such devastation in Diamond Harbour and Saugor Island. 19 persons only are reported to have lost their lives in the Cyclone, of whom 7 were in the Thannah of Baroeepore, 7 in Joynugger, and 5 in that of Mutlah.

SUDDER SUB-DIVISION, CALCUTTA AND SUBURBS.—In Calcutta and the Suburbs, 2 Europeans and 47 Natives were killed in the Cyclone, and 1 European and 15 Natives wounded more or less severely. In the Sudder Sub-division, the total number of deaths reported is the same as in Calcutta, viz., 49, and the deaths are stated by Mr. Verner to be chiefly due to the falling of trees. The storm-wave swept over Atcheepoor and Akra, and at the latter place 5 men were carried away, but the inundation was comparatively trifling as compared with that of the country to the southward.

In the remaining sub-divisions, the loss of life was small, as is shown in the following table, which sums up the data for the 24-Pergunnahs :—

	Deaths in Cyclone.
Saugor Island and Diamond Harbour . .	12,272
Baroeepore	19
Sudder Sub-division	49
Carried over ...	12,340

		Brought forward	...	12,340
Calcutta and Suburbs		...	...	49
Baraset	...	...	...	16
Barrackpore	...	...	...	6
Dum-Dum	...	...	...	7
Baseerhaut	...	...	...	8
Shatkhira	...	...	...	0
		Total	...	12,426

Nuddeah District.

The loss of life in this district has been only partially ascertained. It was, however, very much less severe than in those already noticed, and was due to the effects of the wind mainly. The storm track lay through the middle of the district, which is intersected by several large rivers, crowded with the country boats, which carry on the greater part of the inland traffic of Lower Bengal. There seems to be but too much fear that the loss of life by drowning of the boatmen was very heavy, but as these were chiefly strangers to this part of the country, it is impracticable to obtain any reliable information of the extent of their destruction. The deaths reported by the Police are those of villagers only, and were caused by falling trees and houses. Some also were injured by fire, as the combustible materials of the native huts were blown down on the fires constantly kept burning within, and several villages were thus partially destroyed.

Of the six sub-divisions of the district, Police reports of the loss of life among the villagers, not avowedly imperfect, are before us for four only. In Chooadanga 20 deaths are reported in one Thannah only; from others no returns are before us, but the Sub-divisional Officer remarks that in the Chooadanga Thannah itself no lives were lost, and he is led to infer from the non-forthcoming of other reports, that there was not much destruction of life, though there may have been a few fatal cases of accidents. From Kooshtea there are no returns, but the Assistant Magistrate reports that many boatmen must have been drowned, though two deaths only were reported at the Thannah. Further "I have been about in the villages near this (Kooshtea); there is scarcely

one in which one or more people were not killed by falling houses." Several people were brought into the hospital badly hurt; one or two were suffering from burns. In Ranaghat 54 deaths are reported, but the Deputy Magistrate considers the returns for some of the Thannahs to be much below the truth.

The totals for the several sub-divisions, *exclusive* of deaths by drowning on the rivers, are as follow :—

Sudder Sub-division ...	...	...	80
Mehurpore ...	...	...	123
Kooshtea ...	...	...	?
Chooadanga ...	...	...	20 ?
Bongong ...	...	...	15
Ranaghat ...	...	...	54
	Total	...	292

Rajshaye District.

For this district the Police returns give the loss of life at the several Thannahs as follow :—

Beauleah ...	...	...	5
Tannore ...	...	...	3
Bhowanigunj ...	...	...	7
Bandhaikhara ...	...	...	0
Bilmariah ...	...	...	14
Poothea ...	...	...	24
Charghat ...	...	...	10
Mandah ...	...	...	0
Nattore ...	...	...	26
Shingrah ...	...	...	37
Boraigaon ...	...	...	21
	Total	...	147

Bograh District.

From this district we have no report beyond the fact mentioned in Mr. Eden's Narrative, that in the town itself 12 deaths were reported.

From Jessore and Burdwan Districts we have no reports of any loss of life, but these districts were but little affected by the Cyclone, and if any occurred, it must have been trifling.

To the losses already enumerated must be added those on the river, which are but imperfectly known. The Cooly-ship *Ally* left Calcutta on the morning of the 4th October with 335 emigrants, men, women, and children, for the Mauritius. She was overtaken by the gale 15 miles below Diamond Harbour, and foundered, with the loss of all hands, except 22 of the emigrants and seven lascars. The *Phœnix* and *Dwarkanauth* tug steamers also foundered near Saugor, as already mentioned at page 29, and three only were saved from the former ship. The *Hope* Light Ship was lost with all hands, and the *Persia* Rangoon Steamer foundered at sea with all her passengers and crew, with the exception of the two lascars picked up on a floating piece of the wreck by the *Golden Horn*.

To sum up all the previous data, the following may be accepted as the best account we are enabled to give of the loss of life from all causes in the Cyclone of the 5th October. It is avowedly most imperfect, and we fear, notwithstanding all possible causes of over-estimate suggested by Mr. Montresor and others, much within the truth, but of this our readers must form their own estimate, from the data we have endeavored to abstract as faithfully as possible:—

Midnapore District	...	33,012
Hooghly „	...	2,390
24-Pergunnahs	...	12,426
Nuddeah	...	292
Rajshaye	...	147
Bograh	...	12
Ally Emigrant-ship	...	306
Other ships ...	...	100?
Total	...	48,685

The deaths by the sickness which raged in the districts swept by the storm-wave, and which must be in great part at least attributed to its effects, would, in all probability, not be over-estimated at 25,000 to 30,000.

B.—PRIVATE PROPERTY.

Of the destruction of private property by the Cyclone and storm-wave but little is known, with the exception of the cattle and crops and the shipping in the port of Calcutta, and even in respect to these we have found it impracticable to obtain any estimate of the money value of the property lost or injured. We can, therefore, but sum up the reported losses in the form in which they have been placed on record, our authorities being the official reports of the Civil Officers of Government, and for the shipping, those of Lloyd's Agents in Calcutta, Messrs. Gladstone, Wyllie and Co.

In the districts over which the storm-wave swept, it may be estimated that the loss of cattle amounted on an average to three or four times that of human life; but the numbers reported vary considerably in different Pergunnahs. The following is a summary of the returns before us :—

Midnapore District.

Southern Hidgellee; loss considerable; no returns* ...	?
Erinch, Kusba Hidgellee and Par-Bissian; loss very great; no returns	?
Dutcurea, Kismut Pataspore and Narooamootah; loss considerable; no returns	?
Jellooamootah and Soojamootah; loss small; no returns ..	?
Goomghur	25,267
Aurunganugger	231
Doroo Dummun; loss very great; no returns	?
Cassimnugger	2,772
Mysaudul	16,573
Teraparah	386
Gomai	299
Tumlook; returns imperfect	2,384
Total ...	47,912

* See page 128.

The above returns are taken from Colonel Short's Reports, and are, doubtless, trustworthy so far as they go. The Commissioner of Burdwan states that the total loss of cattle reported for that part of the Midnapore District south of the Roopnarain River, is 95,000, and this, he considers, may be accepted as fairly correct.*

Hooghly District.—Mr. King, the Superintendent of Police, reports the loss of cattle in the Howrah Police District, (the southern part of Hooghly, and which alone suffered by the storm-wave), at 12,762 head. Mr. Montresor computes the loss at eight times that of human life, or about 16,000.

Soonderbuns and 24-Pergunnahs.—In Saugor Island, Mr. Hugh Fraser reports the loss of cattle at 7,000 head. In the Sultanpore Thannah of the Diamond Harbour Sub-division, (which probably includes Saugor Island), the loss, according to the returns collected by Mr. Verner, was not less than 24,192, which is said to amount to five-eighths of the whole number previously owned by the villagers. In Govindpore Thannah the loss was 8 per cent., but the actual number is not reported. In Daveepore Thannah the reported loss is 399, but this is only based on partial returns; and in Bankipore 500. In Baroepore Sub-division, 542 head of cattle were destroyed, (the greater part, viz. 408, in the Joynugger Thannah). In the other Sub-divisions the loss is said to have been trifling. The ascertained loss in the district is therefore 25,633.

Nuddeah District.—As has been noticed in other parts of this Report, the Nuddeah District was not affected by the storm-wave, but the destruction of cattle would appear to have been considerable. The only numerical return before us, is that for Mehurpore, where 3,887 head of cattle are reported to have been destroyed. The Sub-divisional Officers of Chooadanga and the Assistant Magistrate of Bongong report heavy losses in their respective Sub-divisions, but give no numerical estimates or returns.

For other districts we have no returns, but there is no reason to believe that the loss was at all considerable.

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* Mr. Montresor notes that "in these parts cattle have always been most abundant, and are reared not exclusively for agricultural purposes, but for the Calcutta and other markets, where they used to be seen driven in large herds, for sale at the cattle fairs at Tumlook and Oolabarriah.

The injury to the crops by the storm-wave was less on the right bank of the river (in the district of Midnapore) than on the left, (24-Pergunnahs), as the greater part of the country was covered with fresh water (the accumulated rains), which had been held up by the protective works, to the depth in some places, of many feet. Moreover, the salt water remained but for a short time on the land, as it was speedily driven out through the open khalls and breaches in the dykes by the strength of the south-west gale, which set in within an hour or so after the influx of the wave. The chief exception to this is the Pergunnah of Doroo Dummun, where the low level of the interior permitted the storm-wave waters to remain long on the land, so that, as Mr. Montresor reports, the only crops able to withstand the effect of the wave, were those immediately along the embankments.

On the left bank of the river in the lower part of the 24-Pergunnahs the destruction was much more severe. In the Sub-division of Diamond Harbour the loss of the paddy crops amounted to one-half, and in Baroepore to 20 per cent. Higher up, beyond the area of the inundation, the loss of this crop was but trifling, and such was also the case in other districts affected by the storm. The sugar cane, arhur, and other high growing crops, however, suffered severely.

The destruction of trees and houses by the wind was everywhere very great, but the reports received do not admit of anything approaching to a complete estimate of its magnitude. A few instances will, however, serve to give some idea of its extent. Thus, in the town of Tumlook, out of 1,400 houses and huts, only 27 were left standing, and the bazar is said to have been left a mass of ruins. In Calcutta and its suburbs 102 pucka (brickwork) houses were destroyed, and 563 more or less severely damaged;* and 40,698 tiled and straw huts were totally destroyed. In the town of Howrah (with its suburbs), opposite to Calcutta, 152 pucka houses and 14,760 huts were destroyed or severely injured; and in the Police District of the same name, extending southwards to the junction of the Roopnarain and Hooghly Rivers, the Police Returns report 316 pucka houses and 1,50,158 huts destroyed by the Cyclone and storm-wave. On Saugor Island alone 3,565 houses (huts) were swept away by the flood, and the loss in the southern part of the Diamond Harbour Division and the Pergunnahs on the right bank of the

* This probably does not include those that suffered partial stripping of the stucco, loss of sunshades, shutters, windows, &c., injuries which scarcely a single house in Calcutta escaped.

river was almost equally severe. In Mehurpore, a Sub-division of the Nuddeah District, which lay on the central track of the storm, it is estimated that one-eighth only of the native huts escaped, and the destruction extended over a tract of from 40 to 50 miles on each side of the path of the central calm, in diminishing proportion towards the limits.

Dicotyledonous trees of all kinds, especially fruit trees, suffered an extensive destruction; palms lost many of their leaves, but otherwise suffered but little, with the exception of the *Areca*; along the path of the storm vortex, large clumps of bamboos were uprooted and overthrown in great numbers, and plantains were almost universally destroyed. The trees that escaped destruction in and around Calcutta were entirely stripped of their leaves. From a partial numerical survey of the Botanic Gardens, Dr. Anderson reports that at least one-half the trees were blown down, and this may perhaps be taken as the average destruction over a tract of about 15 miles in breadth along the path of the storm. In the park at Barrackpore the destruction of large trees is reported at 50 per cent., and on the Barrackpore road, from the 11th mile-stone up to the Station, at 80 per cent. At Burdwan a few large trees fell, but this Station may be considered as marking the limit of the destruction to the westward, while Jessore, in a similar manner, stands on the border of the area of destruction to the eastward.

The destruction of shipping in the port of Calcutta appears greatly to have exceeded that on record for any previous storm. There were, on the 5th October, 195 vessels in port, either at their moorings or at anchor in the stream. The moorings were held by anchors of 65 and 70 cwt., and the chains laid down after the Cyclone of 1842 were of the heaviest description; at the same time new posts of sal-wood for shore fastenings, 22 feet long by 2 feet square, were fixed along the river bank. It appears, however, that the moorings were of insufficient length, and thus the rise of the river caused by the storm-wave, bringing an additional strain on the chains already stretched to their utmost under the pressure of the Cyclone, caused the ships to break loose in masses, after which they drifted before the blast, carrying before them many of those that had ridden out the storm so far safely in mid stream, and were grounded, a mass of confused wreck, with cargo boats, lighters, and smaller boats of every description, on the sands of Goosery, Seebpore, and Cossipore. Of the whole number above mentioned, but 23 were uninjured on the morning of the 6th October; 39 were damaged but slightly; 97 damaged severely, and

36* were totally lost, or had suffered so severely as to become constructively wrecks. Among these last were the *Azemia*, 1,179 tons, the *Govindpore*, 1,357 tons, the *Lady Franklin*, 1,187 tons, the *Lew Chew*, 854 tons, the *Ville de St. Pierre*, 379 tons, and the *Vespasian*, 919 tons, which sank off Calcutta. The *Baron Renfrew*, 904 tons, which was lost near Diamond Harbour, and the *Ally*, 665 tons, the cooly-emigrant ship, already mentioned, which foundered with the almost total loss of the crew and emigrants, 15 miles below the same station.† A considerable quantity of cargo both on board the ships, and on cargo boats, was either swept away or had to be sacrificed to lighten the vessels. Wrecked property to the estimated value of Rs. 57,000 was rescued by the Police in the town and suburbs of Howrah alone, but the Superintendent is of opinion that, in spite of all exertions, a vast amount was taken and concealed by the ryots, many of whom, it was said, far from suffering by the Cyclone, became suddenly wealthy. The banks of the river at Cossipore were for weeks subsequent to the Cyclone thickly strewn with masses of jute beneath and among the pack of stranded wrecks.

The Peninsular and Oriental Company's Steamer *Bengal*, 2185 tons, was landed high and dry on Shalimar point, where she remained a conspicuous object for more than two months, when she was at length restored to deep water by cutting a dock around her, and towing her out at vast expense. The *Hindustan*, receiving hulk, the property of the same Company, was partly driven on shore, but foundered next morning.

* So reported in Mr. Eden's Narrative. The list given in the note next following enumerates 31 only.

† The following is a list of the ships actually or constructively wrecked, with their tonnage. For this we are indebted to Mr. R. Stewart of Messrs. Gladstone Wylie & Co.

Great Tasmania	2163 tons.	*Carribean*	874 tons.
Sir William Eyre	1315 „	*Aladdin*	867 „
Govindpore	1357 „	*Lew Chew*	854 „
Tchernaya	1223 „	*Fez Robaney*	827 „
Hindustan, P. & O. hulk	1200 „	*Admiral Carey*	743 „
Bentinck, Government hulk	1200 „	*Thames*	706 „
Lady Franklin	1187 „	*Collingwood*	680 „
Azemia	1179 „	*Ally*	665 „
Hanover	1045 „	*Tartar*	647 „
Southampton	971 „	*Dingo*	631 „
Tulja	963 „	*Ashrood*	475 „
Admiral	962 „	*Hindustan*	454 „
Colombo	932 „	*India*	450 „
Vespasian	919 „	*A. J. Kerr*	444 „
Baron Renfrew	904 „	*Singapore*	438 „
		Ville de St. Pierre	379 „

No reliable estimate has been formed of the total value of the shipping and cargo lost or damaged in the port. It was stated at the time to be about two millions sterling, but we have failed to procure any data that would warrant our accepting this as more than a vague guess at the amount. Mr. R. Stewart, a partner of Messrs. Gladstone and Wylie's house, considers that this estimate is much exaggerated, and that it more nearly represents the gross value of the shipping property at stake, while the actual loss was considerably within one million sterling.

C.—GOVERNMENT PROPERTY.

The estimate of public losses includes that of two items only, *viz.*, the injury to public works, and the destruction of the salt stores. The former of these is, however, of exceptional value, as being the only return before us which can pretend to detailed accuracy, and we have accordingly deferred the publication of this Report for some months in order to include the information, which, we were aware, was in course of collection on this head. In the return, the cost of the original construction of the works injured is given in the great majority of cases, and we have thus the data for estimating, approximately at least, the ratio between the actual destruction and the whole value of the property at stake. We shall first summarise the estimates of the total destruction, and then give a few instances of the amount of injury proportional to their value, suffered by some of the more important works.

MILITARY WORKS UNDER THE CHARGE OF THE GARRISON ENGINEER.

	Rs.	A.	P.	£	s.	d.
Fort William, Calcutta	22,689	0	6			
Maidan, Cooly Bazar, Kidderpore, Allipore, and Dullunda ... } Calcutta ...	17,357	0	0			
Dum-Dum	39,757	0	0			
Cossipore	6,600	0	0			
Barrackpore	2,18,918	0	0			
Ishapore	11,217	0	0			
Chinsurah	16,189	0	0			
	3,32,727	0	6	33,272	14	0¾
				£33,272	14	0¾

Civil Works.

	Rs.	A.	P.	£	s.	d.
Presidency Division (Buildings in Calcutta and suburbs)	1,60,736	0	0	16,073	12	0
24-*Pergunnahs Division.*						
Embankments	1,72,570	0	0			
Sluices and bridges	1,318	0	0			
Buildings	90,278	8	0			
Roads	12,322	0	0			
	2,76,488	8	0	27,648	17	0
Calcutta Canals and Akra Division.						
Tramway and embankment (Akra)	913	8	5			
Buildings (toll-houses, &c.) ...	8,793	8	2			
Materials	1,200	0	0			
Live Stock (Akra)	120	0	0			
	11,027	0	7	1,102	14	1
Jessore Road Division.						
Buildings	6,402	5	0			
Roads	6	0	0			
	6,408	5	0	640	16	7½
Nuddeah Local Road Division.						
Buildings	645	8	0			
Roads and bridges	104	0	0			
Materials	185	0	0			
	934	8	0	93	9	0
1*st Division Grand Trunk Road.*						
Buildings at Serampore, Hooghly, &c.	39,336	1	0			
Bridges, Road, Bungalows, &c. ...	3,899	0	6			
Boats	2,334	13	0			
	45,569	14	6	4,556	19	9¾
Carried forward ...				£50,116	8	6¼

			£	s.	d.
	Brought forward ...		50,116	8	6¼
Burdwan Local Road Division.					
Buildings	271 0 0		27	2	0
Damoodah Division.					
Embankments	34,661 0 0				
Buildings	13,795 0 0				
Sluices and drain bridges ...	7,490 0 0				
Roads	6,514 0 0				
Spurs	114 0 0				
	62,574 0 0		6,257	8	0
Tumlook Division.					
Embankments	1,90,839 0 0				
Buildings	22,810 0 0				
Sluices and bridges	27,791 0 0				
Roads	9,548 0 0				
	2,50,988 0 0		25,098	16	0
Midnapore Division.					
Embankments	11,465 0 0				
Buildings	5,513 0 0				
	16,978 0 0		1,697	16	0
Hidgellee Division.					
Embankments	1,68,274 13 0				
Buildings	33,256 10 3				
Sluices and bridges	30,881 2 0				
Roads	3,317 0 0				
	2,35,729 9 3		23,572	19	2
Carried forward ...			£1,06,770	9	8¼

			£	s.	d.
	Brought forward ...		106,770	9	8¼
Balasore Division.					
Buildings	1,397	0 0	139	14	0
Mahanuddy Division.					
Embankment (False Point) ...	100	0 0			
Sluice „ ...	400	0 0			
	500	0 0	50	0	0
Berhampore Division.					
Buildings	303	1 6			
Materials lost	1,279	0 2			
	1,582	1 8	158	4	2½
Rajshahye Division.					
Buildings	3,604	4 11			
Materials lost	1,564	0 0			
	5,168	4 11	516	16	7½
Total Civil	...	...	107,635	4	6¼
„ Military	...	...	33,272	14	0¾
			£140,907	18	7

The items of destruction may further be summed up as follows :—

	Rs.	A.	P.	£	s.	d.
Embankments	5,78,823	5	5			
Sluices and drain bridges ...	67,880	2	0			
Buildings, Civil	3,87,141	14	10			
„ Military	3,32,727	0	6			
Roads	35,710	0	6			
Miscellaneous	6,796	13	2			
	14,09,079	4	5	140,907	18	7

The ratio between the value of the exposed property and the injury it suffered varied very greatly, according to the extent to which it was protected by surrounding objects. This is well shown by the following Table, which exhibits in one column the estimated or recorded value of the works specified, and in the other columns the cost of their repairs, and the percentage of this on the former sums.

		Value.	Repairs.	
			Total.	Percentage of value.
		Rs.	Rs.	
Injured by Wind ...	Fort William (Buildings)	27,16,492	13,421	0·5
	Calcutta and Suburbs (Civil Buildings)	88,23,810	1,32,484	1·5
	Cossipore (Military Buildings) ...	1,68,961	6,600	3·9
	Dum-Dum (do. do.) ...	11,39,858	36,941	3·2
	Barrackpore (do. do.) ...	7,28,440	2,07,361	28·5
	Chinsurah (do. do.) ...	3,84,671	14,589	3·9
	Hooghly (Civil Buildings) ...	2,33,726	30,050	12·8
Injured by Flood ...	Embankments of Damoodah Division..	1,10,627	34,661	31·0
	Sluices and drain bridges, Hidgellee Division	1,23,022	30,881	25·0

The smallness of the destruction in Fort William, is probably due to the protection afforded to the buildings by the glacis and fortifications, and in like manner, the mutual protection afforded by the crowded buildings of Calcutta may be held to account for the fact that their destruction was less than half as great as that suffered by the buildings of Dum-Dum and Cossipore. But greater exposure alone cannot be held sufficient to account for the extreme devastation of Barrackpore, nor will the greater proximity of that place to the central track satisfactorily account for the excess, inasmuch as Chinsurah and Hooghly were both much closer to the central calm, and on the same side of it as Barrackpore, while, being situated on the right bank of the river, they were even more exposed to the unbroken force of the wind than Barrackpore. The destruction of trees, so far as we can gather from description, was not less at Chinsurah and Hooghly than at Barrackpore.

The loss and destruction of salt stores is only in part that of Government property. The chief loss was at the Narainpore Golahs (Storehouses), where out of a total quantity of 2,00,045 maunds in store on the morning of the Cyclone, 1,07,045 maunds were destroyed. The value of this quantity, at Rs. 399 per 100 maunds, is Rs. 4,27,111, to which may be added the cost of the buildings, viz. Rs. 18,190, making a total of Rs. 4,45,301. The Rusoolpore Golahs (Hidgellee) were also destroyed, but Mr. Montresor reports that there was no material loss of salt.

The total loss of salt on ships and boats lying in the river, as well as that swept from two Golahs at Hautkollah, was 2,43,060 maunds, which, at Rs. 399 per 100 maunds, bore a total value of Rs. 9,69,809. Thus, in the item of salt alone, there was destruction to the amount, as ascertained, of Rs. 14,15,110 [£141,511], the greater part of which was borne by the Government.

The above are the only items for which actual estimates of the value of Government property destroyed in the Cyclone are before us, but they are far from representing the total destruction of public property. The lines of Electric Telegraph, the dockyards, buoys and river vessels, all suffered more or less injury, and a number of valuable records were lost from Offices in Calcutta and elsewhere. The Railway lines also suffered severely. At Kanchrapara on the Eastern Bengal Railway, a magnificent series of unfinished workshops was totally destroyed by the wind, and many of the Stations of the East Indian Railway suffered partial unroofing and other injuries. We find it impracticable, however, to form any estimate of the total loss thus borne by the community. It appears to be generally agreed that had even a few hours warning of the approach of the Cyclone been given, the destruction of the shipping and, to some extent also, the injury of house and other property in Calcutta might have been diminished, and our main object in these pages has been to prepare such a record as may, to some extent, facilitate the prognostication of any future visitation of a similar character.

APPENDIX.

Extract of Log of Ship " CLARENCE," J. WATSON, *Captain, from Madras towards Calcutta.*

H.	Courses.	K.	F.	Winds.	Remarks—Monday, October 3rd, 1864.
1	E by N.	6	...	Northerly.	A. M. 1—Squally appearances to Eastward. In Royals and Flying jib, Mizen top-gallant sail and cross jack, 1-30, wore to the Nd.
2	.....	4	...	.....	
3	NW by N ½ N.	6	...	ENE.	
4	.....	6	...	.....	Heavy squalls with rain. In top-gallant sails.
5	NNW.	7	...	NE.	Strong breeze and squally.
6	.....	7	...	and NNE.	Well 11 in.
7	NW ½ N.	6	...	.....	7 h. Moderating. Set driver, main and fore top-gallant sails. 8 h. Fresh
8	.....	6	4	.....	breeze and fine weather.
9	N by W ½ W.	7	...	.....	Employed trimming ship by shifting cargo from after hold to fore hold.
10	.....	7	...	.....	
11	N ½ W.	7	..	.....	Carpenter variously.
12	.....	7	...	.....	Noon, Fresh breeze and squally.

Lat. obs. 18°17 *N., Long. obs.* 88°33′ *E.* *N.* 29 *E.* 58 *miles.*
Bar. 29·87, *Symp.* 29·56, *Ther.* 84, *Air* 85, *Water* 86.

1	NNW.	5	...	NE.	P. M.—Unsteady breeze and squally, with rain.
2	.....	5	...	.....	Set mizen top-gallant sail.
3	.....	6	...	NE.	Fresh breeze with heavy squalls; in fore and mizen top-gallant sails.
4	.....	6			
5	.....	5	...	.....	5-30, *T. K. D.* Ship to E. S. E.
6	ESE.	5			
7	.....	6	...	.....	Fresh breeze and hazy. In main top-gallant sail and 1st reefs of top-sails. Well 11 in.
8	.....	6	...	.....	
9	NW.	6	...	.....	Fresh breeze with squally appearances.
10	.....	5	...	SE.	9-30, Shift of wind to SE.
11	NNW.	5	...	ESE.	
12	North.	5	...	.....	Midnight strong breeze with squally appearances.

Extract of Log of the Ship "CLARENCE," J. WATSON, *from Madras towards Calcutta,—(continued.)*

H.	Courses.	K.	F.	Winds.	Bar.	Remarks—Tuesday, October 4th, 1864.
1	NW by N ½ N.	4	4	NE.	.....	A. M. Strong breeze and
2	....	4	4		29·76	squally, with rain.
3	NNW.	4	...	ENE.	29·75	3h. Heavy squall from eastward, lowered the topsails.
4	.....	3	...		29·75	
5	.....	3	...	NE.	.....	Increasing to a gale with
6	.....	3	...	.....	29·70	every appearance of bad weather; shortened sail to close-reefed topsails.
7	.....	1	...	NE by E.	29·70	Sent down the royal yards,
8	.....	1	...	.....	29 72	unbent flying jib and royal staysail, sent topgallant studsails out of the
9	.....	1	...	.....	29·72	tops and unrove gear.
10	.....	1	...	.....	29·69	10h. Every appearance of being near a cyclone, bore up to S. S. W., and furled mizen topsail.
11	SSW.	8	...	NNE.	29·63	11h. Wind veered to NNE, blowing hard with torrents of rain and a confused sea on.
12	South.	8	...	North.	29·59	Noon. Wind veered to north. hard squalls; very heavy rain and confused sea on.

Lat. acc. 18°56′ *N. Long. acc.* 88°12′ *E.* *N.* 27, *W.* 44 *miles.*

Bar. 29·59, *Symp.* 29·38, *Ther.* 82, *Air* 82, *Water* 83.

1	SSE.	9	...	NNW.	29·50	P. M. Blowing a hard gale
					29·43	with furious squalls and
2	SE.	9	...	NW.	29 39	torrents of rain. Kept
					29 41	the ship before the wind,
3	ESE.	9		W by N.	29 38	altering her course as
					29·35	the wind veered.
4	East.	9	...	WSW.	29·35	High cross sea on.
5	ENE.	9	...	SW by W.	29·38	Blowing most furiously with
	ENE.	4			29·36	a deluge of rain; secured
6	NNW.	1		SW.	29·38	sails, boats, booms, &c. &c., with extra lashings.
7		1	...	.....	29·48	5-30. Having sailed round
8	NW by N.	1	...	.....	29·53	the cyclone till the centre
					29·54	bears NW., furled the fore topsail, and hove to under close reefed main
9	NW by W.	1	...	.....	29·60	topsail.
10	.....	1				8h. Hard gale with con-
11	.....	1				stant rain; well 12 ins. strong gale, with hard squalls and heavy rain.
12	.....	1	...		29·66	Midnight. Ditto wind and weather. Heavy sea on.

Extract of Log of the Ship "CLARENCE," J. WATSON, *Captain, from Madras towards Calcutta,—(continued.)*

H.	Courses.	K.	F.	Winds.	Remarks—Wednesday, October 5th, 1864.
1	NW by W.	1	...	SW.	A. M. Decreasing and clearing up, with a high sea on.
2	.....	1			
3	NW by W ½ W.	1			
4	.....	1			
5	.....	...	...	.....	High cross sea running from all directions. Daylight—Fresh breeze and cloudy.
6	NNE.	2	...	SSW.	
7	.....	5	...	.....	Bore up NNE. and made sail to double reefed topsails, whole foresail and fore topmast staysail.
8	.....	5			
9	.....	5	...	.....	Well 13 in.
10	.....	5	...	.....	Employed drying sails and gear, &c.
11	.....	5	...	South.	Out 2nd reef of main topsail, and set main top-gallant sail.
12	.....	5	...	.....	Noon. Fresh breeze and squally, with rain.

Lat. obs. 19°16′ *N.* *Long.* 88°46′ *E.* *N.* 58, *E.* 38 *miles.*
Bar. 29·77, *Symp.* 29·61, *Ther.* 82·

1	North.	6	...	South.	P. M. Moderate breeze and squally, with rain.
2	.....	6			
3	.....	6	...	.....	Moderate and cloudy, with light rain at times.
4	.....	7	...	.....	Out 2nd reefs of fore and mizen topsails, and set top-gallant sails.
5	.....	7			
6	.....	6	...	.....	Light breeze and fine.
7	.....	5	...	.....	Well 15 in.
8	.....	5			
9	.....	4	...	.....	Ditto wind and weather.
10	.....	4			
11	.....	5	...	.....	Midnight. Sounded; no bottom at 60 fathoms.
12	N by W.	5			Distance by patent Log 48 miles.

Log of H. M.'s Bengal Steamer " PROSERPINE,*" J. V.* FALLE, ESQ.*, Commander, proceeding from Calcutta towards Akyab.*

H.	K.	F.	Courses.	Winds.	Bar.	Therm.	Remarks.—Sunday, October 2nd, 1864.
1	...	...	... ...	...	...	...	A. M. Fine clear weather.
2	...	...	Under Pilot's charge.	...	...	...	Daylight. Weighed and proceeded.
3	...	...	... ...	...	...	...	Very light winds, and calms.
4	...	...	... ...	Southerly	...		9 h. Passing through the Gasper Channel. Washed decks, and made every thing ready for sea; secured boats, &c., with the exception of the Cutter.
5	...	...	... ...	...	...	...	
6	...	...	... ...	...	...	...	
7	...	...	... ...	...	...	...	
8	...	...	... ...	Southerly	...	...	10 h. Sighted the Pilot Brig "Foam;" steered.
9	...	...	... ...	...	...	...	12 h. Up with her; eased and stopped for her boat. Lowered the Cutter and filled her with Pilot's traps, then filled the "Foam's" boat and proceeded on easy, to tow the boats close to the brig, but owing to the carelessness of the seacunnie in the Brig's boat, she swamped alongside and got adrift. Lowered the Jolly Boat and picked up all the traps; brought the boat alongside again, righted her, again loaded her.
10	...	...	... ...	...	...	...	
11	...	...	... ...	...	...	...	
12	...	...	... ...	...	...	...	

1	...	...	... ...	...	...	...	P. M. ... ... and put the Pilot on board the Brig. Hoisted up boats.
2							
3	7	...	E by S ¼ S. ...	...	...	...	2. Set course and steamed.
4	8	...	... ...	Calm ...	29·84	...	Fine clear weather. Light winds.
5	7	4	... ...	...	...	83	3. Pilot Brig bearing N. W. ½ W.
6	7	4	... ...	...	...	...	8 P. M. Well 3½ ft. 2½ aft
7	8						E. R. 3½.
8	8	...	... ...	ENE.	29·83	79	Light breeze from the eastward springing up.
9	8						
10	8						
11	8						
12	8	...	... ...	ENE.	29·83	76	Midnight. Fine and clear.

Log of "PROSERPINE,"—(*continued.*)

H.	K.	F.	Courses.	Winds.	Bar.	Therm.	Remarks.—Monday, October 3rd, 1864.
1	8	...	E by S ¼ S. ...	...	...	...	A. M
2	7	...	... ...	...	...	...	Set jib and Try sail.
3	7						
4	7	...	... ...	NE.	29 90	80	Daylight. In sails. Stowed some chain down aft to put her down by the stern. Washed decks.
5	7						
6	7						
7	8	...	... ...	...	...	...	Vessel steaming very badly.
8	8	...	... ...	NE.	29·92	86	
9	8	...	... ...	...	...	...	9-30. Patent Log, showed 118 miles.
10	7	4					
11	6	1	... ...	...	...	...	A swell coming up from S. Eastward.
12	6	4	... ...	Easterly.	29 90	89	Noon. Fine and clear.

Lat. obsd. 20° 09′ N. *Long. Chr.* 90° 17′ E.

1	4	...	E ½ S. ..	...	...	...	P. M. Altered course to E. ½ South.
2	3						
3	2	...	... ...	...	...	...	Fresh breeze from the
4	3	...	... ...	East ..	29·86		Eastward, with increasing swell.
5	2	4	... ...	...	...	...	Furled foremost awnings.
6	2	...	... ...	...	...	...	6 h. Sent down main topmast.
7	2	...	... ...	...	...	...	Dirty appearance to the Southward, and heavy
8	2	...	... ...	East ...	29·82		swell from the Eastward. Vessel making very little
9	2	...	... ...	...	...	...	head way.
10	1	4	... ...	...	...	...	Pumps 2 ins. aft 5 feet; Engine room clear. Mid-
11	2	...	... ...	...	...	...	night, lightning to the Eastward, with increasing
12	2	...	... ...	East ...	29·80		sea, and every indication of bad weather. Barometer falling.

Log of "PROSERPINE,"—(continued.)

H.	K.	F.	Courses.	Winds.	Bar.	Therm.	Remarks.—Tuesday, October 4th, 1864.
1	1	4	E. ½ S.	...	...	...	A. M. Blowing a fresh gale from the eastward, with increasing sea, and falling Barometer. Sent tackles aloft to send the fore yard down, but finding the vessel rolling so heavily, did not start it with the few men we had, kept rolling tackles on to steady it.
2	1						
3	...	...	Hove to; the vessel lying about 5 points off the wind, first on one and then on the other, being totally unmanageable; not answering her helm.	East ...	29·76	74	
4							
5							
6							
7							
8	...	...	...	East ...	29·76	80	Gale increasing and sea rising tremendously, and the vessel labouring greatly; kept the fore pump at work constantly. Barometer falling slowly.
9							
10							
11							
12	...	...	...	East ...	29·74	83	Noon. Cloudy, with passing showers. Wind blowing in violent gusts. Pumps 2 inches aft. 11 forward, 13 Engine-Room.

Observation none—supposed position, Lat. 20°-30′N, Long. 90°-40′E.

1	...	...	... ...	...	...	..	P. M. Engine-room Bilge pump [?], injection got choked with coals; sent men to pump out that compartment with hand pumps. Engines making only 8 revolutions; battened up the foremost hatches, the vessel taking water in over her forecastle.
2	...	...	Head				
3	...	...	to				
4	...	...	...	East ...	29·72	80	
5	...	...	NE.				
6							
7							
8	...	...	Head	E. by S.	29·70	76	Pumps 2½ aft, 13 Engine-room, 7 forward. The gale still increasing, vessel rolling very heavily; lost the galleys, unshipped and broken, sponson, houses washed up; water ways under paddle box leaking very badly; water increasing in the engine-room, kept it under as well as we were able with the ships's pumps, comport ditto, and fire engine. Midnight, Sea increased to a frightful extent, vessel laboring heavily. All the men completely knocked up, servants included.
9							
10			to				
11	...	...	NE.				
12	...	...	... ...	E. by S.	29·70	76	

Log of "PROSERPINE,"—*(continued.)*

H.	K.	F.	Courses.	Winds.	Bar.	Therm.	Remarks.—Wednesday, October 5th, 1864.
1	...	...	... ...	...	...	...	A. M. Gale still increasing. Immense heavy seas breaking over the forecastle, and fore deck; 3-30, on sounding the fore compartment discovered that there was 3 ft. 6 inches water in her; took off the hatch, and set all hands at work to pump and bale the water out, found the lower deck washed up, and beams and planks, &c., dashing about below, threatening to go through the side or water tight bulkheads, as the water gained over us, closed the hatch, and battened it down; proceeded to shore up the after water tight bulkheads with paddle floats, shore planks, &c., to render it as lasting as possible; sent all available hands to the pumps, the water in the engine-room increasing very fast, there being now two feet there; the gale appearing to be now at its height; the vessel plunging into the seas, leaving over two feet of water on the upper deck. Commenced cutting away the lower part of the bulwarks, and after great difficulty, succeeded in getting several holes made, which slightly relieved the immense pressure forward; cleared away the boats as much as we dared, and put water and provisions into them, fully expecting the vessel to go down under us. Let go both anchors, and ran out 60 fathoms of chain on each, and threw overboard all heavy moveable articles on the fore-deck, including galleys, vice bench, lathe, forge,
2	...	...	Hove				
3	.	...	to				
4	...	..	... ...	ESE. ...	29·67	72	
5	...	...	Head				
6							
7	..	...	SE.				
8	..	...	... ...	ESE. ...	29·64	76	
9							
10							
11							

Log of " PROSERPINE,*"—(continued.)*

H.	K.	F.	Courses.	Wind.	Bar.	Therm.	Remarks.—Wednesday, 5th October 1864.
12	...	...	... ...	ESE. ...	29·64	80	safe, grindstones, and every thing we could to lighten her forward: vessel totally unmanageable the whole of this time: found it impossible to get her before the wind, as she would not answer her helm in any way: lost, while attempting to do so, jib stay-sail. Foretopsail, Foretry-sail gaff, and topmast studding boom, also two tarpaulins from fore rigging; the men at this time being quite exhausted and worn out with constant pumping. The wind veering now to the southward a little, and a fearful sea running; Barometer steady.

Position by indifferent observation, Lat. 21°05′; *Long.* 90°32′ *E.*

1	...	...	... ...		...	...	P. M. The weather appearing to brighten up a little, all hands still at the pumps. Barometer not falling, and every appearance of a change; every soul in the vessel employed at the pumps, but being so exhausted, were scarcely able to keep them going; carried away the fore topmast, and fore royal stays; secured them as well as possible.....band on foremost got adrift; the yard was only held by the tackles, ship rolling and labouring very severely, sea not appearing to decrease in the least.
2							
3							
4	...	...	Head	SE. ...	29·61	81	
5							
6							
7	...	...	to				
8				SE. by S....	29·66	74	
9*							*8. Strengthened the backing of the water tight compartment with two more ..... and some paddle boards; midnight, the weather seems clearing up, but there is still a fearful sea rolling.
10	...	...	NE.				
11							
12				SSE. ...	29·70	70	

*Log of "*PROSERPINE,*"—(continued.)*

H.	K.	F.	Courses.	Winds.	Bar.	Therm.	Remarks.—Thursday, October 6th, 1864.
1	...	...	... ...	...	...	...	A. M.—Wind and Sea decreasing.
2	...	...	... ...	...	...	...	Daylight, opened the fore scuttle, and discovered that the decks, pieces, hatches, &c., washing about, had broken open the two foremost scuttles
3							
4	...	...	.. ...	SSE.	29 70	72°	After great exertions we succeeded in jamming them with joggles from the outside, when with all the buckets, pumps, &c., we commenced baling and pumping, and gained a little on the water, sufficient for the Carpenter to secure them; but did not get on very fast, as the seas were continually
5							
6	..	...					
7							
8	...	...	Hove to.	SSE.	29 70	80°	washing over us.
9							
10							
11							
12	...	...	... ...	SSE.	29·70	80°	Wind still decreasing and the sea going down: sent part of the crew to rest, the whole being totally exhausted; still gaining on the water in the fore compartment; Barometer steady, but not rising very fast. The vessel still continues unmanageable owing to the water forward bringing her down by the head. Noon, still clearing.

Lat. Obsd. 20° 34′ *double acct.—Long. Chr.* 91°16′.

H.	K.	F.	Courses.	Winds.	Bar.	Therm.	Remarks.—Thursday, October 6th, 1864.
1	...	...	.. ..	...	...	...	P. M.—Half the men employed pumping out the various compartments; ship still not moving against the head sea.
2							
3							
4	...	...	.. ..	South.	29·73	80	Revolutions increased to 11 vessel. began to move through the water; heavy squalls of rain.
5							
6	2	...	SE.				
7	2		... ..	...	...	..	Weather much finer; sea going down.
8	2	...	... ..	South.	29·78		
9	2	...	. ...	...	...	...	9-30, finished pumping out the fore compartment: sent half the men to rest.
10	2	4	... ...	...	...	..	10.—Stopped and sounded: no bottom at 50 fathoms. Midnight.
11	2	4					
12	3	4	... ...	...	29·78		

Log of "PROSERPINE,"—*(continued.)*

H.	K.	F.	Courses.	Wind.	Bar.	Therm.	Remarks.—Friday, October 7th, 1864.
1	5	...	ESE. ...	...	...	..	A. M.—Fine weather, sea going down fast.
2	5	4	... ...	...	...	...	A. M. 2.—Stopped and sounded in 55 fathoms
3	5	4					water: sand and mud.
4	6	..	... ...	Southerly	29·80	72°	A. M. 4.—Stopped and sounded 50 fathoms: sounded the pumps, and found 8 inches in the foremost compartment, it is supposed some rivet heads are started. D. L., sighted high land to the eastward: stood in for it. Hands employed pumping ship, getting things straight aloft and on deck, and getting the stream anchor over the bow, and chain from aft.
5	6	4					
6	6	..					
7	7	..	East.				
8	7	...	... ...	Southerly	29·83	79°	
9	7						
10	7						
11	7						
12	7	...	.. ...	Southerly	29·82	87°	Noon.—Fine and clear.

St. Martin's Island bearing N. by E.

1	7	...	SE. ...	...	...		P. M. 1.—Sighted Oyster Island.
2	8	...	ESE. ...	...	..	...	P. M. 2.—Passed it.
3	8	...	... ...	...	...	86	Washed decks.
4	8	...	... ...	Southerly	29·84	...	6-30.—Entering Akyab Harbour.
5	8	...	... ...	..	...		Burnt a blue light in answer to several from the shore.
6	8						
7	...	...	... ...	...	...	...	7-15.—Eased, stopped and anchored off Government Ghaut, Akyab, in 4 fathoms, and veered chain to 45 fathoms to the hawse. Banked fire.
8	...	...	... ...	Southerly	29·87	80°	
9							
10							
11							
12	...	...	... ...	Southerly	29·83	74	Midnight—Cloudy, but fine.

(Sd.) J. V. FALLE,
Commander.

(Sd.) W. C. SMART,
1st Officer.

Log of the Bengal Government Pilot Vessel " CHINSURAH," *Mr. T. Smartt, Branch Pilot, Commander.*

Date.	Hour	Barometer.	Thermometer	Well F	Well A.	Wind	Weather.	Position.	REMARKS
Sunday Oct. 2nd 1864	4 A. M.	29·96	85	8½	7	Light Westerly ..	Fine	At ℄ E C L, S E by S. 3 miles.	4-30 A. M.—Weighed and proceeded towards "Kedgeree" P.V.; 5-20, anchored again, no wind; 9 A M., weighed, made "Comet" N. and W.; 10-30, ℄ clewed up and anchored in 9 fms. E C ℄ SE by S 1½ miles; 11-30 observed "Foam" P V.'s boat to capsize alongside Str. "Proserpine," tripped and sent our boat to assistance, 1 A M., veered to 20 fms. E. C. ℄, NNE, 1 mile
	8 ,,	..	86	.	..	,, N. W. ...	,	Ditto.	
	Noon.	29·94	.	..	.	,, Easterly ...	,,	At ℄ E C L. N N E, 1 mile	
	4 P. M.	29·92	87	..		,, Southerly	..	Ditto.	
	8 ,,		85	..	.	Calm .	,,	Ditto	
	Mid	...	...	.		,, Southerly .	,,	Ditto	
Monday, Oct. 3rd, 1864.	4 A M	29·96	84	8½	7	Light N. E. ...	Fine	At ℄ E C L, NNE. 2 miles.	6 A M - Weighed and sighted a Steamer to westward 11-40, sighted a Steamer to eastward clewed up and anchored in 8 fms., ECL℄. S. E. 3 miles; veered to 25 fms. chain, 8 P. M. veered to 45 fms.
	8 ,,	... ..	85	...	...	,, ...	,,	E C L, SE by S, 4 miles	
	Noon.	29·95	86	...	...	,, ,, ...	,,	At ℄ ECL, SE, 3 miles.	
	4 P. M.	29·94	87	.	...	,, E N E. ..	,,	Ditto.	
	8 ,,	29·95	84	...	...	Mod. Easterly with lightning all round.	Cloudy.	Ditto	
	Mid.	... ..	..	...	...	Fresh Easterly ...	Squally.	Ditto	
Tuesday, Oct. 4th, 1864.	4 A. M	29·94	84	8½	7	Fresh Easterly breeze and squally, with rain and heavy sea.	Squally.	E C L, N E by E, 4 miles.	2-30 A. M.—Weighed to supply 2 inward-bound vessels and stood down to southward, weather having a very threatening appearance all round; 4 A. M., split main topsail and bent a new one; single reefed the topsails and double-reefed the spanker; 6 A. M., took Mr. Master Pilot Beale out of the Ship "Earl Dalhousie;" 6-30, put Mr. Junior Mate Pilot Wall on board the Barque "Inspector," bent main staysail 9 A. M., double-reefed the topsails; 11-30 close-reefed the spanker; 1-30, furled the courses, fore-topsail and spanker, and put extra lashings on the whole of them; 2 P. M., sent down top gallant yards; 3 P M., furled main topsail with extra lashings and hove to under the fore top mast staysail; 4 P M., port waist anchor broke adrift from its lashings and came on board; secured it, also secured starb'd waist anchor and both lower anchors with extra lashings; battened down fore and aft and opened the man-holes below; 7-30 P. M., split the fore topmast staysail and set the reefed main staysail; 9-30, split the main staysail; about 11 P M. the main sail got adrift and blew all to pieces, from 6 P. M. until midnight blowing a very violent gale from east to ENE, Sea kept down by the wind, vessel on her starboard side buried down to the combings of the hatches, in which position she lay from 10, P M. until 1 A M. next morning. Sea washed overboard, all the lee hencoops,
	8 ,,	29·86	83	10	9	Blowing a very violent gale from E. to ENE. with no sea.	Very squally	Ditto	
	Noon.	29·80	86	...	...	Blowing a moderate gale from East, and very heavy sea.	Squally & dirty	Ditto	
	4 P. M.	29·60	84	...	...	Blowing a hard gale from E. to ENE. with heavy sea running	Heavy & thick.	Ditto.	
	8 ,,								

	Mid.	28·80	83	Could not sound the well.		Blowing a very violent hurricane from ENE., no sea, but blinding spray.	Very squally	E C L not in sight.	broke 1 or 2 of the weather ones, also breaking adrift the small boat from the davits and smashing it all to pieces; carrying away quarter deck awning, breaking the gallery on the starboard side, and 1 of the gun ports: the vessel being constantly under water to leeward, and labouring heavily.
				In.	In				
	4 A M.	29·50	86	26	29	Blowing a moderate gale from N W, & heavy sea.	Dirty & squally.	At Sea	From 1 to 3 A. M gale gradually working round to the northward; blowing with extreme violence, and terrific Sea running, vessel being constantly under water and labouring very much 1 A M—The main topsail blew out of the gaskets and lashings, and blew to ribands; 3 A. M., gale commenced moderating, and by daylight had moderated considerably; commenced to
	8 ,,	·60	..	...	...	Blowing a fresh breeze from W, and heavy sea.	Cloudy	Ditto.	clear away the wreck and send down remnants of torn sails; 7. A. M., set
Wednesday, October 5th, 1864	Noon.	76	...	20	15	Fresh S W; heavy sea.	do	Ditto	the double-reefed fore topsail foresail and fore-staysail and ran to the
	4 P M.	·80	...	10	9	Fresh S W.	Fine.	Ditto	northward to make the Station; 9 A M, bent and set single reefed main
	8 ,,	·85	...	...	...	Ditto	do	Ditto	topsail, and during the morning bent and set new main sail and fore top-
	Mid.	·90	...	...	...	Fresh S.	Squally.	Ditto	mast staysail; shook out all the reefs and set jib and spanker; pumped the vessel out: 4-30 P. M., sent up topgallant yards and set topgallant sails; 8 P. M. gave over charges of the deck to Mr. Master Pilot Beale.
	4 A. M.	30·2	84	10	9	Moderate S	Fine.	25 Fathoms mud.	Daylight, 2 strangers in sight; 6 A. M., sighted a vessel to westward at
	8 ,,	... ..	...	...	...	Light S	do.	Ditto	anchor; 7 A. M., observed vessel to eastward to be dismasted; ran down
	Noon	4	..	..	...	Light E	do.	At ⅄ 25 Fathoms mud.	towards her; 9 A M. anchored in 25 fms (mud) and veered to 45 fms.
	4 P M.	·1	85	...	...	Light E N E.	do	F P Light-house W by S	chain; 10-15 A M. the dismasted vessel drifted past us 2 or 3 miles to east-
Thursday, October 6th, 1864	8 ,,	·3	84	...	..	Light N E	do	At ⅄ F P Light-house S W ½ S	ward and proved to be a Panah with a whiff at the masthead: noon, weigh- ed with a light easterly breeze and stood to northward; 2 P. M., sighted False Point Lighthouse, 5 P. M, hoisted our No and sighted
	Mid.	.....	...	..	..	Ditto	do.	Ditto	the mast and yard of some wreck: 5-30, sighted some more spars and ran towards them, they proved to be spars lashed together, apparently a raft and quite new Beacon on Point Reddie bearing W by S ½ S.: 6 P M., clewed up and furled and anchored in 8. Fms. False Poin. Lighthouse S. W ½ S.

J. E. OWEN,
Standing Mate

Extract of the Log of the "Comet" F. L. Vessel during and after the late Cyclone, and until the "Chinsurah" Pilot Vessel assumed the Station in the Eastern Channel.

October 4th.—Daylight, fresh ENE. winds and thick rainy weather; Barometer 29·86. "Foam" P. V. at anchor to the N. W. about 2 miles distance; at 7h. A. M. winds freshening: veered away cable to 120 fathoms. Noon, fresh gales from the ENE., Barometer 29·85; sighted a Schooner to the eastward, standing to the northward; at 4h. P. M. hard gales from E. by N.; very high sea, and strong squalls with thick rain, Barometer 29·72; sighted under the squalls "Foam" P. V. bearing W. by N., with a staysail hoisted, heading about SSE.; sunset, hoisted the Station Lantern half mast; vessel riding very heavy; battened down the hatches, and prepared for very heavy weather; could not burn maroons; burned half hour blue lights; at 8h. P. M. shipped very heavy seas; Barometer 29·60; gales increasing and sea rising; dark weather with thick rain. At 11h. 30m. P. M. parted from the starboard anchor, cleared and let go port anchor; cable parted at 45 fathoms while veering away; lowered down the Station Lantern, shewed no more lights; Barometer 29·50.

October 5th, A. M.—Vessel drifting in a WNW. direction, heading from SE. to S., sea breaking in the vessel fore and aft; the storm still from the ENE.; starboard quarter-boat filled and carried away; davits and all: awnings blown away with booms and stanchions; fore staysail blown away; also the foresail under double gaskets: the storm was then fearful; port quarter-boat staved against the mizen rigging; cut it adrift, and soon blown away. companion cover and forehatch tarpaulin washed away; shipped much water below; got hatches secured again and rigged the pumps; 2½ feet water in the hold; Binnacle lamps, hen-coops, and every thing about the decks washed away, vessel laid over very much; at 4h. A. M., Barometer 29·35, the storm from the east as hard as ever; at 9h. A. M., Barometer 29·46, the storm veering round to SE. with little lulls: pumped ship out to 8 inches. Noon; storm moderating and veering round to south and westward: Barometer 29·50, hove in the end of the cables and found that the starboard coir cable had parted at 120 fathoms: bent chain cable on port waist anchor; at 4 P. M. got anchor and cable ready; let go and veered away to 45 fathoms of chain, and 80 fathoms of coir cable spliced on the chain in 7½ fathoms of water: fresh wind and squally: supposed the vessel to be in the South Channel; cleared up decks for the night, showed a light in the starboard foreyard arm during the night. At midnight Barometer 29·70, wind WNW. moderate.

October 6th.—Daylight, Barometer 29·75; light variable winds through the day and the Barometer rating from 29·75 to 29·90; had an observation and found the vessel's position to be in Latitude 21° 10', Longitude 88° 02', in 7½ fathoms in the Channel, 15 miles to the WNW. of our station, across the Eastern Reef; employed all day in getting spare anchors out and cables bent on; at 1h. P. M. a large wreck passed, drifting to the westward; at 7 P. M. another wreck passed close to us: being dark, could make nothing of it; shewed a light on the starboard foreyard arm.

October 7th.—Light variable winds and fine weather through the day, employed during the day in transferring cables from one side to another; at 7h. 30m. A M. a

vessel sighted to WSW. standing to the WNW., hoisted to him Ms. Ce. 3729 : sent topmast up and set the rigging; at sunset a ship at anchor to E by S, far off; shewed a light on the starboard yard arm during the night.

October 8th.—Light variable winds and cloudy weather; a ship at anchor to E by S. far off; at 9h. A. M. ship weighed and stood to the N. W.,.....
; at 10h. A. M. Ship "Golden Horn" hove to close by, and sent a boat on board of us, gave to the Officer in the boat our position, and informed him about the weather we have had; the Officer of the Ship "Golden Horn" reports having had fine weather, but a very strong westerly current; also reports having seen two wrecks, and picked up two Lascars from "Persia" or "Omer Persia." Sent up all spars, set the rigging and bent sails; at 3h. 30m. P. M. sighted a Steamer to the NNE.; at 5h. 30m. P. M. Steamer "Orissa" came within hail, and asked if we were in need of any assistance; answered that I wish to be taken in tow to our station; the Pilot in charge of the Steamer asked what was our position; answered 15 miles from our station on an ESE. course; asked me to cut my cable, he would take me in tow, to which I agreed; at 6h. P. M. passed hawsers, cut the cable and proceeded in tow; at 8h. P. M. cast off from the Steamer and came to with starboard bower in the Eastern Channel in 8¾th fathoms of water; veered away cable to 30 fathoms; Messrs. Marriott and Woodroff, Pilots, came on board; shewed a light on the starboard yard arm.

October 9th.—At daylight sighted part of a buoy bearing S. S. E., and Ship "Golden Horn" at anchor to the W. S. W.; light northerly wind and squalls; at noon Mr. Marriott, Pilot, went on board the Ship "Golden Horn" and took pilotage charge; could not get an observation through the day. Attempted to get close to the buoy, but could not stem the tide, the wind being very light; not being sure that the buoy was in her proper position, hoisted no flags during the day, and only a yard arm light during the night.

October 10th.—Daylight, moderate easterly winds and squalls with rain; Ship "Golden Horn" and a Tug Steamer at anchor to the westward; at noon had an observation, found the buoy to be on her position; hoisted the station flag; signalized to all the vessels coming from sea Ms. Ce. 425; at sunset three vessels at anchor, and three vessels coming in; hoisted the Station Lantern and shewed the usual lights; at 8h. 30m. P. M. the S. S. "Celerity's" boat came alongside, Mr. Benzley came on board, inquired about the state of the vessel, and reported both Gaspar Lights off the Station.

October 11th.— Daylight, moderate westerly winds, tripped the anchor and made all sail, and at 7h. A. M. took our station; Station buoy bearing N. by W. ½ W., about ¾ of a mile distance, in 10 fathoms of water; five vessels at anchor and five under sail; Ship "Pleiades" asked for Pilot; answered, gone to sea in a gale of wind; at 11h. A. M. communicated with Steamer "Bull Dog," Mr. Woodroff, Pilot, went on board; sent down all sails, rigging, spars, &c.

Steamer "Bull Dog" communicating with all the vessels in the station; sunset, Steamer "Bull Dog" at anchor to the westward; five vessels at anchor and three under sail; all apparently with Pilots on board; shewed the usual lights.

October 12th.—Daylight, light N. W. winds and fine weather; Steamer "Bull Dog" cruizing about in the station, and nine vessels in different bearings; at 9h. A. M. "Star" L. V. passed up in tow of a Tug Steamer; at 9h. 30m. "Chinsurah" P. V. came to the station and anchored to the WSW.; at 1 P. M. Mr. T. Smart, Branch Pilot, Senior Officer of the Cruizing Station, came on board and inspected the vessel.

"COMET" L. V.,
EN. CHANNEL,
October 17th, 1864.

(Sd) GEO. L. BARBARO,
Chief Officer in charge.

Copy of the Log of the "Foam" P. V., 4th October 1864.

At 1 A. M. fresh ESE. wind and squally appearances; 2 A. M., ESE. wind and squally appearances, Barometer 29·68, Thermometer 84. "Chinsurah" P. V. E ½ S.: E. C. Light SE ½ S.; at 2-30 A. M. a ship in tow of steam passed us, without showing any lights for her Pilot to be taken out; and observed that the "Chinsurah" P. V. had altered her position, bearing now south of us; 3 A. M., observed the outward-bound Ship and Steamer close to the "Chinsurah" P. V.; at 4 A. M. fresh ESE. wind with rising sea: veered away cable to 60 fathoms to the hawse; daylight, strong ESE. wind and heavy sea; E. C. Light SE ½ S. and Lower Reef Buoy WNW. "Chinsurah" P. V. not in sight; at 8 A. M. fresh ESE wind and heavy sea; Barometer 29·68; Thermometer 84; E. C. Light SE. ½ S. 9 A. M., the wind still freshening and getting squally; veered away cable to 90 fathoms. 11 A. M., the wind still freshening from ESE and squally, with a heavy sea rising; veered to 125 fathoms to the hawse. Noon, Barometer 29·60, Thermometer 84. Blowing very fresh from ESE, and heavy sea; E. C. Light S E. ½ S. At 1-30 P. M. sighted a Schooner to the eastward; hoisted 6873 M. C. to her, and she wore round and stood to sea. 2 P. M., Barometer 29·55, Thermometer 84. Blowing very fresh from ESE. and squally, with a rising sea. 3-45 P. M., the cable parted outside the hawse, and as the weather was rapidly getting worse with a heavy sea rising, shipped the cable at the 135 fathoms shackle, and stood to sea under reefed foresail, fore topmast staysail, and fore staysail, close-reefed main topsail and reefed main staysail. 4 P. M., blowing a strong gale with heavy squalls, and sea from ESE., Barometer falling. 4-30 P. M., observed the E. C. Light bearing east: this was the last we saw of her; 6 P. M., the fore topmast staysail and fore staysail split to pieces; bent a new fore staysail and set it, the gale increasing in violence, with a very heavy sea; battened down all the hatches. 8 P. M., blowing a violent hurricane from east, with a very heavy sea; the vessel labouring heavily and shipping a great deal of water; the Barometer falling rapidly. Between 9 P. M. and 10 P. M. the foresail, main staysail, and main topsail split to pieces and blew away from the yards, Barometer 28·45. At 11 P. M. blowing a furious hurricane, and the vessel shipping a great deal of water and burying herself; the quarter-boat was washed away, carrying the davits along with it; at 11-20 P. M. while under bare poles, from the violence of the wind, the vessel was thrown so much over on her broadside, that the whole of

the starboard rail was completely under water, and the decks quite flooded with the sea, which was breaking up the hencoops and washing every thing overboard; cut the main mast away for the safety of the vessel and the lives on board, which gave immediate relief; by this time the Barometer had fallen to 28·10; midnight, still blowing a furious hurricane from east, with the sea one mass of foam and the vessel labouring heavily and shipping heavy seas, and the decks full of water, obliged to remain hove to and trust to Providence, as nothing else could be done. The Native Crew having at the commencement stowed themselves away, the Officers on board had to do all that was required, which they did with spirit and energy and most creditably to themselves; the Barometer still remaining at 28·10.

5th October 1864.—At 1 A. M. still blowing a furious hurricane from ENE. with a very heavy sea, and the vessel labouring violently, with the wreck of the masts towing alongside, as we were unable to cut them away; at 1·30 A. M. the Barometer commenced to fluctuate between 28·30 to 28·40, and the wind veered to NE. 3. A. M., still blowing a heavy hurricane, and the wind veering rapidly to north; Barometer 28·40. At 4 A. M. heavy hurricane, with the wind round to WSW. and a heavy sea; Barometer 28·50; wore the vessel round on her starboard tack with her head to the southward. Daylight; commenced to clear away the wreck of the masts from alongside, the wind having considerably moderated and veered to S. W.; but still a heavy sea, Barometer 28·85. At 8 A. M. fresh SW. wind and cloudy with a very heavy sea; the crew still employed in clearing away the wreck from alongside; bore up to the northward, but owing to the heavy sea that was running, found it unsafe to scud with any sail; at 9·30 A. M. got the foresail bent and steered up north; fresh SSW. wind and the weather rapidly clearing up, but the vessel rolling heavily owing to the heavy sea that still continued. 10 A. M., fresh SW. wind, and the weather rapidly clearing up; Barometer 29·40. Noon; moderate SSW. wind and heavy sea; Barometer 29·60; steering up north, and the vessel rolling heavily: Latitude by observation 20°14′ North; no soundings. 2 P. M., moderate SSW wind, and the weather getting fine and the sea going down. At 4 P. M. ditto ditto wind and weather; Barometer 29·70. Sunset; light ditto wind and weather; nothing in sight; 8 P. M., light SSW. wind and fine; Barometer 29·73, Thermometer 84. Sounded the well and found 2 feet aft and 3 feet 2 inches forward, commenced to pump out. 10 P M., ditto ditto wind and weather, Barometer 29·73, Thermometer 83; steering up north in soundings.

(Sd.) S. BARTLETT,
Acting Standing Mate.

(Sd.) G. B. SMART, B. P.,
Commander.

Account of the Cyclone; (Ship "MARTABAN"); Saugor Road.

		Direction of the wind
Tuesday, October 4th.	Civil time, 12-30 P. M.; strong breeze and heavy squalls; came to with the port anchor at 45 fathoms of cable; sounding 9½ fathoms of water; mud bottom; Saugor flat buoy, bearing by Com. E. by S., do Light House SE. by S., Kedgeree Light House NW ½ W. Light and watch attended to; at 10 P. M. increasing breeze and constant heavy rain ...	NE. by N. NE.
Wednesday, October 5th.	Midnight, strong gale and rain; at 3 A. M. gale still increasing; 4-30 A. M., all hands were called up to let go the second anchor. It was blowing pretty heavily, and Pilot gave order to send down royal and top-gallant yards. Wind hauling to ...	ESE. to South. NE.
Remark. 1	*Gale increasing at the rate of two every quarter of an hour.*	
5 A. M.	Had cleared everything for sending them down, when it commenced to blow a heavy hurricane; 5-30; she commenced to drag her anchors, and we had to heave up more	E by N.
2.	cable and pay it out; 7-30, *still increasing* 1. It blew so hard by this time that the sprays cut our legs and faces whilst coming in contact with us; 8, *still increasing* 2; 8-30, saw the Steam Tug "Phœnix" dragging her anchors, and coming broadside on to us. She had her masts and funnel standing, but all her sails were hanging in shreds to them. All our masts standing. 9 A. M.; by this time the hurricane increased to a Cyclone; 9-30, *increasing* 2. Jibboom gone, and likewise the fore royal and top-gallant masts; at 10, main-mast went by the board, all sails fast, carrying with it the mizen topmast; 10-30, fore topmast carried away, and the 2nd Mate and Young tried to get up aloft to cut away the topmast rigging which was still hanging to the masts. By means of a deal of struggling we managed to get up half way, but the	E ½ S. E by S. SE. SSE. SE. by S. 10-45, wind hauling as far as ENE.
3.		
4.		

wind throwing us against the rigging with such violence, it was an impossibility to get up any higher, and we were obliged to come down; we did so with difficulty. 11, Ship labouring heavily, dragging both anchors at 7 fathoms water; our masts were lying alongside of us, and one or two of us tried to cut them away at the risk of our lives; we could not stand upon our feet, as the seas washed us under the rigging and wreck, and most of the crew were completely helpless; *5 fathoms water.* 11-15, the ship swung, bringing the wind on the starboard side where the wreck was lying. Atmosphere brightening up, *the wind died* 3; 11-45, *wind increased*, it blowing a terrific cyclone. We were below lashing the chests and clearing the sails which were all wet, the half-deck being half full of water, when we were called up to look out for ourselves; it was thought that the main mast would be blown in board; 12, the sea wave, we supposed, brought us 3 or 2½ fathoms more, as we had 5 fathoms shortly afterwards. It carried our spars away, washing them on the cable, which we had to clear to pay it out. 12-30; the decks were completely covered with mud, and pieces of wood which were cutting our legs, so we had to throw them overboard ... ...

Stopping at the quarter 15m., then hauling round the compass as far as NW by W. Barometer 28·150; 11-30, it rose to 28·350. Thermometer 68°, fell to 61°, rose suddenly to 67°.

Soundings 3 fath.

NW.

NNW.

1 P. M.—Gale decreasing; commenced cutting away the wreck doing damage to the ship's side; was on the main yard with hammer and chisel cutting the mizen topmast stay and lifts and halyards, when our starboard anchor carried away at 75 fathoms, throwing me into the water. I got in a tow line and was hauled on deck, to get ready another anchor and heave up more cable. 3 P. M. wind abated, leaving us a total wreck. Finding we had dragged 17 miles across the banks at low tide, leaving us only sufficient water to float.

Barometer 28·500, rising fast.

4. P. M. 28·870.

Wind gradually drawing N.

Remarks on force of wind.

8. A moderate gale. All numbers in the remarks are added to the previous number 8. Words can hardly express on paper, or even by a person himself, the extent of this cyclone, as it would be hard to express what was really felt during the time. However, I have done my best to express myself in the above account.

From Mr. Branch Pilot G. Noaks, Comdg. *Kedgeree* Pilot Vessel, to Offg. Master Attendant,—(dated 10th October 1864.)

I have the honor to report for your information the arrival in Calcutta of the Pilot Vessel *Kedgeree* totally dismasted in a hurricane.

My cruise having expired, I was ordered in by the Senior Officer with directions to proceed to Diamond Harbour and await orders.

On the 4th instant the vessel anchored a little below the Western Reef Buoy with 30 fathoms cable; moderate north-east wind and fine weather; the wind freshened during the afternoon, and cable was given as necessary till 1-30 A. M. On the 5th, when blowing very fresh from the north-east, veered to 70 fathoms on the port cable, and let go the starboard anchor with 30 fathoms. At 6-30 A. M. veered to 95 fathoms on the port anchor, and 75 on the starboard. Endeavoured to get royal and top gallant yards down.

At 8 A. M. still only fresh gale from the eastward; barometer 29·87.

About 9 A. M. wind suddenly shifted to south-east, blowing a perfect hurricane, and we parted from (as I supposed at the time) both anchors, and commenced driving; the top gallant masts and starboard quarter boat blowing away.

11-30 A. M.—Vessel lying with her hatches in the water.

Noon.—Vessel still lying hatches under; and having a great quantity of water below in imminent danger of foundering, I cut the main mast away. This did not ease the Brig at all, and the foremast followed, when the vessel righted, and we were enabled to get rid of the water on deck and below. Barometer at noon 28·54.

1 P. M.—The hurricane was at its height, the bowsprit was blown out of the vessel, the port quarter boat blew to pieces, and the large boat amidships was struck by a sea to leeward, and hove from its position into the port waist.

3-30 P. M.—Clearing and slightly moderating.

4 P. M.—Barometer 29·20, moderating very rapidly, when we found the vessel to our astonishment, off Hospital Point; also sighted a vessel ashore.

The port cable was hove in, and we discovered we had lost about 70 fathoms; another anchor was bent; the vessel dropped to Diamond Harbour and anchored

for the night. The next morning, on heaving in the starboard chain, we found the stock of the anchor bent only.

Our barometer gave no indication of anything extraordinary till the hurricane was on us, when it fell with unexampled rapidity : the sea was tremendous, and during my period of service, I have never experienced anything approaching to the force of the wind on this occasion.

Letter from the Superintendent of Cowcolly Lighthouse ; see foot note to Report, page 34.

From JAS. DANIEL, ESQ., Supdt. Cowcolly Lighthouse, to CAPTAIN H. HOWE, Depy. Master Attendant,—(dated Cowcolly, 4th August 1865.)

I have the honor to acknowledge the receipt of your letter No. 2038, dated the 4th August 1865, which came to hand late last evening, and beg most respectfully to state that the wind did not at any time during the cyclone of last October shift to the west; on the contrary, after the lull, the wind from being NE. blew ESE. with a tremendous puff occasionally from East, this continued without any intermission till close upon 3 P. M., when there was a second slight lull, or stand-still; this I believe was caused by the wind moving round, which was not perceptible, although a rushing sound could be much apparently at a great distance; this was not the case in the first lull: very shortly after the wind broke out with a terrific roar from SW. this continued with unabated fury till near to P. M. when it gradually calmed down: the night was fine, but there was a great deal of lightning, and distant thunder from NW. all fore part of night; the wind remaining at SW. all that night, but shifting to NW. towards the following morning; from which quarter it blew for several days in succession.

We reprint the following, as being one of the most graphic accounts we have received of personal experience of the storm and storm-wave by a gentleman who was fully exposed to their fury, and who narrowly escaped with life, but which being too long for insertion in the text of the Report, we have reserved for the Appendix :—

" I left Calcutta (Garden Reach) at 5 P. M., on Tuesday, and reached Ooloobariah at about 7-30. It was raining and blowing rather hard from the North. I started from Ooloobariah in my buggy to drive the first stage at 8-30, but had not got two hundred yards from the bungalow, before my mare fell badly on her haunches in the mud, carrying away the splinter bar of the buggy, and bursting the harness so badly, that I had to cut the remainder away. I sent her back to the bungalow, the buggy remaining where it was, coolies not being procurable until next day. I next sent for a palkee and bearers to take me this stage. These I

procured about 10 P. M., when I started, reaching my own dâk at about 1-30 A. M. About half an hour after I started with these, *i. e.*, about 2 A. M., it began to blow in heavy fitful gusts from the North, so strong that I could not carry the torch alight. This and the bad weather retarded me, so that at 6 A. M. of Wednesday I had only just reached the bank of the Roopnarayun, which was only 6 miles from the last stage; thus I had been 4½ hours doing these six miles. On reaching the ferry ghaut, I found it perfectly impossible to cross. The river was extremely rough, and the ferry boat could not have lived in it, even if it had ventured across to me, which it refused to do. So, after vainly shouting for the ferry boat, I repaired to a mud hut close to the ghaut, about 50 yards from it. Now, you must know, that the Roopnarayun is a large river, having its source in the Chota Nagpore hills, and being therefore subject to rise rapidly after rains. On this account it is confined between two magnificent embankments 12 or 14 feet high. Where the Midnapore road meets these embankments, it (which is itself raised 9 or 10 feet) slopes down through the embankments to the water's edge. The hut into which I had gone was about half way down this slope and *outside* the embankment. Well, I and my bearers sat contented in this hut, my palkee being about 100 yards on the road above me. From 6 A. M. to 10 A. M it blew *hard* from the North; at 11 A. M. the wind was due East. About noon we began to fear for our hut, which shook fearfully. However, we could not leave it, as it and one next to it were our only shelter; and, moreover, it would have been impossible to face the wind, which would have blown us into the river. So matters went on till about 12, when the hut next to us resolved itself into a heap of mud. A few minutes after this there was a most curious sound in the air, exactly like the letting off steam from a steamer, but of course on a gigantic scale; and then the Cyclone burst on us in all its fury. First, we saw my palkee being rolled along like a barrel round and round, until it was brought up by the ruins of the mud hut which had fallen. There it stuck on its end almost, having been forced into an upright position by the wind. Then the roof of our hut was lifted off like the lid of a box on its hinge, and immediately the walls crumbled into their original mud. There were still left some of the posts standing, which were rather sheltered (as *we* were) by the ruins of the hut to windward of us; and to these posts we clung. Soon I heard my bearers talking in a frightened manner with a few stray villagers who were with us. They then nervously asked me the time. I told them just past twelve noon. Then they said that at half-past twelve a high *bore* was to be expected; that it would be much higher from the water forced down to meet it by the North wind, being suddenly relieved of the pressure of that wind on its becoming East, and that, therefore, they confidently expected that the river, if it did not break the bunds, would at least rise upon the road to as high as where we were, in which case we were lost. You may imagine it was not pleasant. We watched as much as we could, (for it was difficult to see twenty yards off through the driving rain, or rather mist) the rise of the water; and sure enough, though I did not see any actual *bore*, the water all at once suddenly rose as if by magic, and slowly rolled towards us. The top of the wave appearing to be only two or three feet lower than the top of the bund. The people then seized me by my two arms and dragged me out of the ruined hut; and tried to run away from the water. But

directly we were away from under the protection of our windward hut, we were laid flat on our backs by the wind. Finding it impossible to make head against the wind, we sat and laid on the road, forced to await the approach of the water. Of course I gave myself up for lost. But the men pointed out to me that most of the water was already pouring itself over each side of the road behind the bunds. This gave us a little heart; nevertheless, the tide was so strong, that the water reached us exactly at 10 minutes to one, at which hour, being up to my waist, my watch stopped. The water, however, carried us sideways into our old hut in its fall over the road embankment; and to these old hut poles, and to two cocoanut trees that were there, we clung for dear life up to our middle in the water, for two long hours and more. All this time death, sooner or latter, seemed almost inevitable. At about half-past two, however, the wind suddenly moderated, and we waded back on to the high part of the road. By this time it was a perfect calm. Then the bearers said that about $\frac{3}{4}$ of a mile above the road, there was a village, where there was a pucka house in which I might take shelter. I went with them and found that the village was itself $\frac{1}{4}$ of a mile off the road, and had to be waded to; this I did in water some times up to my arm-pits. I had hardly been a quarter of an hour in the house, before the storm began again, this time from the West; having gone exactly half round the compass. Then it blew worse than ever it did before, for about two hours, when it gradually abated and by 6 P. M. there was only a strong West wind. I found that the house people, poor souls, found me in the way, so I waded back to my palkee, which my bearers had recovered and washed. In it, dripping wet, I passed the night, and next morning early, the river having gone down as suddenly as it had risen, hailed the other side for a boat, and was told there was no such thing. And sure enough when day light came I saw the havoc that had been made. Where there had been a flourishing village called Koila, there was literally nothing, but a few naked poles: not a boat to be seen where before there had been scores. By 10 A. M. the next day, (Thursday), which was a beautiful hot cloudless day, I had dried my clothes, &c., and was comparatively comfortable, but that nothing could be got to eat; at last I got five plantains. Late in the afternoon the village people on the other side discovered the ferry boat. It was a mile above the village and had been blown to the top of the bund. They easily threw it down the face of the bund towards the river. But there was still some 300 feet to high water mark, so they set about cutting a canal for the boat, hoping to float it at high tide. This they accomplished, thanks to a very high *bore* that came, and at about 5 P. M. on Thursday I crossed the Roopnarayun. Up to the time at least 400 people had accumulated at the ghaut, hoping to get across, and I had some difficulty, first to procure myself a passage when the boat arrived; and, secondly, to prevent too many people coming in her. Thus I had been thirty-five hours at this river, and with next to nothing to eat. On arriving on the other side, I found my fresh bearers had gone away. My old ones being nearly starved, refused to take me on—but they got a hackery for my palkee, and I walked the next stage, where I found a Thannah, and was fed and provided for, arriving at Midnapore at 6 A. M. on Friday. Any thing like the desolation on the road

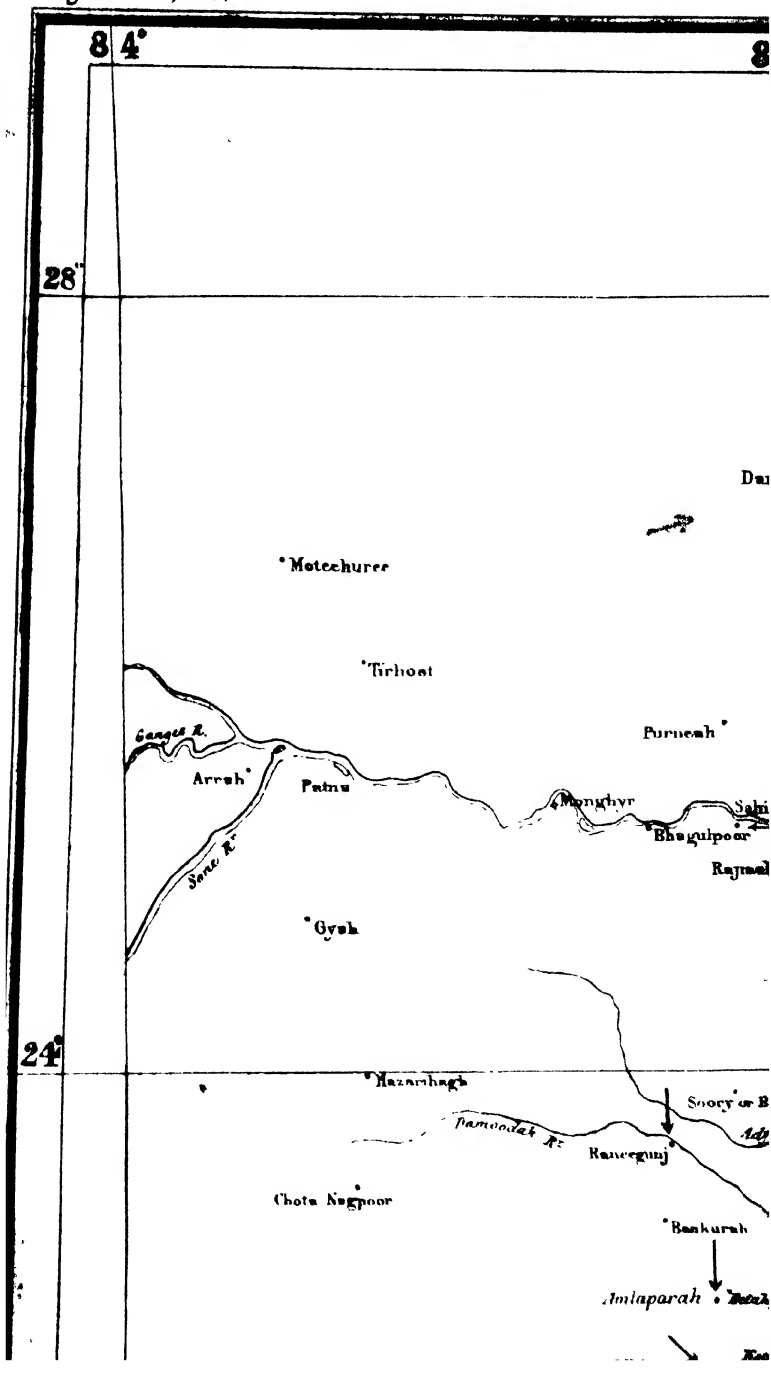
I never saw. It is no exaggeration to say that there is not a single house standing. The Darogah told me that up to the time he was speaking to me, he had received reports of the deaths of 224 named persons within his Thannah alone. At Tumlook only 27 houses, and they pucka, are standing out of 1,400. The pucka house in which I took refuge had had its top story blown down.

List of recorded Storms in the Bay of Bengal.

The Roman figures in the first column refer to the numbers of the late Mr. Piddington's Memoirs in the Journal of the Asiatic Society of Bengal. The small italics to the letters on the chart No. III in the Sailors' Hornbook by the same author.

	Day and Month.	*Year.*	*Place of origin or where recorded.*	*Course.*
	11th, 12th October	1737	Calcutta	?
	17th, 20th May	1787	Coringa	?
	December?	1789	Coringa	?
r.	November	1797	North of Bay	?
a.	October	1800	Ongole storm	?
b.	December	1803	N. Ceylon	?
c.	January	1805	N. Ceylon	?
d.	May	1811	Madras	?
XXII.	11th May	1814	Chittagong and Noacolly	NNW.
q.	November	1815	Bay E. of Ceylon	W.
p.	October	1818	Madras	?
e.	March	1820	Kistnapatam	?
s.	May	1820	Nellore	WSW ?
f.	June	1822	Burrisaul and Backergunge	NW.
g	May	1823	Balasore	NNW.
h.	October	1831	Balasore	?
i.	October	1832	E. Long. 99°, N. Lat. 9°	?
j.	May	1833	Mouth of Hooghly	?
n.	May	1834	Khyook Phyoo	?
	3rd August	1834	Calcutta	?
k.	31st August	1835	Calcutta	?
l.	October	1836	Madras	?
t.	October	1836	E. of Point Calimere	?
m.	October	1838	Kedgeree	?
o.	November	1838	Khyook Phyoo	?
I.	3rd, 5th June	1839	E. Long. 90°, N. Lat. 20°	W by S ½ S.
II.	19th, 21st September	1839	Chittagong	NW by N.
II.	10th November	1839	W. of Andamans	WNW.
,,	22nd November	1839	N. E. of Andamans	?
III.	27th April, 1st May	1840	S. E. of Andamans	NW.

V.	16th May	1841	S. or S. W. of Andamans	WNW.
VII.	31st May, 5th June	1842	N. and N. E. of Bay	WNW. and NNW.
VIII.	22nd October	1842	S. E. of Andamans	W.
IX.	2nd, 5th October	1842	N. E. of Bay	WNW. and N.
X.	21st, 23rd May	1843	E. Long. 89°, N. Lat. 9°	NW.
,,	19th May	1843	N. E. of Ceylon	W. ?
XI.	28th Nov., 2nd Dec.	1843	E Long. 90°, N. Lat. 5°	NW.
XII.	9th, 14th November	1844	S. E. of Andamans	W.
XIV.	29th Nov., 2nd Dec.	1845	E. of Ceylon	W. by N.
XVIII.	12th, 14th October	1848	E. Long. 89°, N. Lat. 17°	NW.
XXII.	15th July	1848	Sandheads	?
,,	12th, 13th May	1849	Chittagong	?
XX.	23rd, 28th April	1850	E. Long. 92°, N. Lat. 9°	N.
XXII.	17th, 19th November	1850	Andaman Sea	N.
XXI.	30th April, 5th May	1851	E. of Point Calimere	NW.
XXIII.	21st, 23rd October	1851	E. of Vizagapatam	NNE.
XXIV.	12th, 15th May	1852	E. Long. 99°, N. Lat. 16°	N.
	July	1859	Calcutta	?
	2nd, 5th October	1864	N. W. of Andamans	NNW.
	25th October	1864	N. of Bay	N. ?
	5th November	1864	Masulipatam	W. ?
	November	1865	E. of Ceylon	N. ?


84°
28°
24°
Motechuree
Tirhoot
Ganges R.
Arrah
Patna
Sone R.
Gyah
Purneah
Monghyr
Bhagulpoor
Hazarhagh
Ramgunj
Chota Nagpoor
Bankurah
Amlaparah